THE WEATHER AND CIRCULATION OF JULY 1958 [1]

Heavy Precipitation Associated With a Trough in Central United States

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1. 30-DAY MEAN CIRCULATION

The outstanding feature of the monthly mean circulation pattern at 700 mb. for July 1958 was the large-amplitude wave which extended from the central Pacific to central North America (fig. 1). The circulation in the remainder of the Northern Hemisphere was characterized by blocking over the North Atlantic, with the westerlies strong and displaced well to the south. Over Eurasia a weak flow of rather chaotic nature existed with many truncated troughs and ridges.

Another striking characteristic of this July's circulation was the large percentage of troughs and ridges which were located in climatologically infrequent positions. Klein and Winston [2] have showed that 30-day mean troughs and ridges have climatologically preferred regions of occurrence (fig. 2). A prominent aspect of their statistics is the small longitudinal width of the bands of high frequency, and the rather extensive in-between areas where very few, if any, troughs or ridges were observed during their period of study. In order to compare this July with the long-period frequencies, the 30-day mean trough and ridge locations for July 1958 (taken from fig. 1) have been superimposed on figure 2A and 2B, respectively. This July a minority of the troughs and ridges were located in the preferred areas, namely, the troughs over California, northeastern Canada, southern Russia (between the Black and Caspian Seas), and eastern Siberia. On the other hand, this is the first July since the records began in 1933 that a trough has been observed in the eastern Bering Sea. The activity in this trough is attested by the high incidence of cyclones in that area (Chart X). Furthermore, the troughs which were observed in the central United States, Atlantic, and western Siberia were located in relatively unfavored areas. Quite similar statements may be made about the ridges. Most important to the Western Hemisphere were the unusually located ridges over New England and just off the Washington-British Columbia coast. Because so many of its major components were not in their usual regions, the mean circulation of July 1958, taken over the entire Northern Hemisphere, was of a type seldom observed in midsummer.

The pronounced nature of the trough and ridge systems in the central and eastern Pacific, together with their location in climatologically unfavored areas, resulted in major height departures from normal. The largest of these were a positive center (260 ft.) just off the British Columbia coast and a strong negative anomaly in the central Pacific which affected both the circulation and weather over the United States. Vorticity flux from out of this Pacific wave was strong and persistent enough to produce cyclonic flow and below normal heights (and temperatures) over most of the central United States, in spite of the continental (thermal) factors which normally support anticyclonic conditions aloft in this area during July.

The circulation in June 1958 [5] was more typical of summertime with a trough along each coast and a ridge over the Rocky Mountains. During the month of June, the trend was toward filling of the west coast trough and more cyclonic flow over central United States. This trend continued into July, as illustrated by the anomalous height rises along each coast and falls over the Plains (fig. 3). Confluence, which had been prominent in June [5], still existed over the United States, even though the California trough was weaker and the branch of southerly flow therefore diminished.

Downstream in the Atlantic blocking was prominent, as shown by the positive anomaly over Greenland and the large area of negative anomaly to the south (fig. 1). The westerlies were depressed and cyclonically curved from the United States to Europe. A major cyclone track was associated with these westerlies, resulting in a very stormy July over central Europe. The cyclones which formed over central and eastern North America had west to east paths which converged near Newfoundland and formed this major storm track across the Atlantic to Great Britain (Chart X).

2. TRANSITION WITHIN THE MONTH

The mean circulation for the month was made up of essentially two regimes. The primary pattern, which is exemplified by a 5-day mean 700-mb. chart (fig. 4), was characterized by a stronger than normal Bermuda High,

[1] See Charts I—XVII following p. 284 for analyzed climatological data for the month.

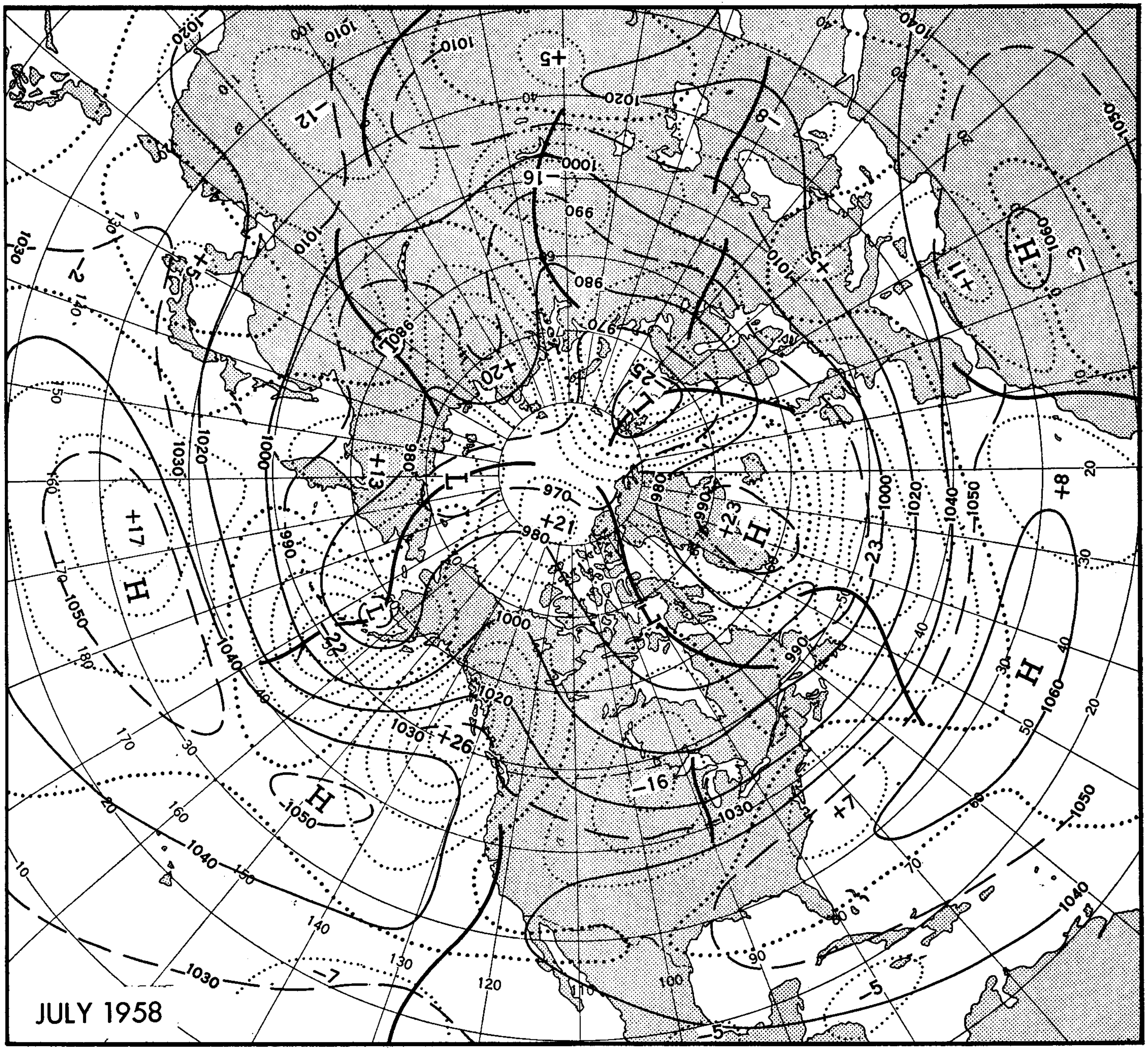

FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for July 1958. Important feature was the large-amplitude wave extending from the trough in the central Pacific to the trough in the central United States.

a major trough through the central United States, and an abnormally weak trough along the west coast. There was a pronounced ridge in the eastern Pacific and western Canada, a low center in the eastern Bering Sea, well east of the normal location, and a center of cyclonic activity in eastern Siberia near 60° N., 120° E.

The secondary circulation regime of July 1958, which is illustrated by another 5-day mean chart (fig. 5), differed from the primary regime over the United States in that the west coast trough was deeper and the center of cyclonic activity, previously over central United States, shifted to the east coast. These dissimilarities are attested by the height change between the two 5-day mean charts (fig. 6), with rises in central United States flanked by falls along both coasts. Upstream there was a shift of the major area of cyclonic activity from the eastern to the western section of the Bering Sea and a marked weakening of the low center in eastern Siberia as the blocking High over northern Siberia moved eastward (fig. 6). Most of the month the primary pattern prevailed,

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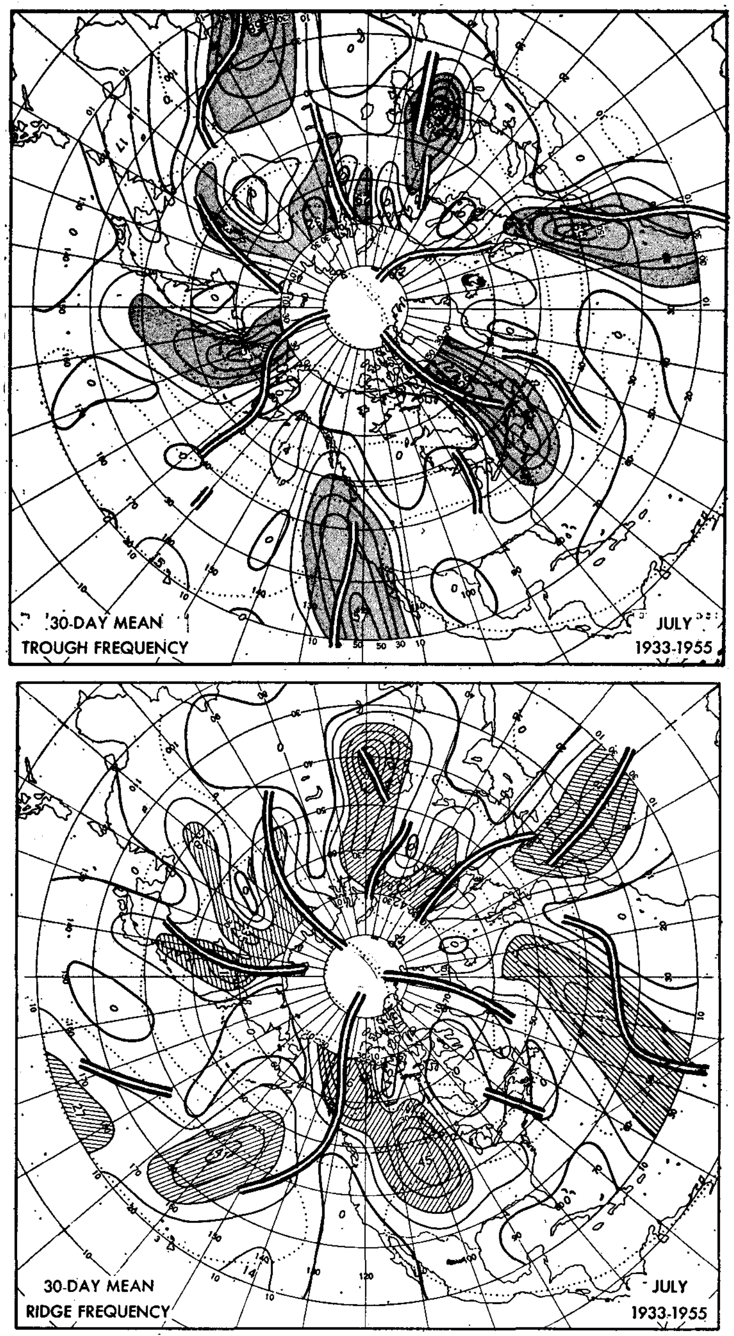


FIGURE 2.—Percent of time that troughs (A) and ridges (B) on 30-day mean 700-mb. charts were located within 10° longitude intervals at latitudes from 20° N. to 70° N. for July, for the period 1933–1955. The data were adjusted to an equivalent basis with 10° at 50° N. as the unit. The lines of equal frequency are drawn at intervals of 10 percent, with the zero line heavier. Areas with frequency greater than 20 percent are shaded. The light dotted lines are the normal 700-mb. contours for July. The 30-day mean troughs and ridges for July 1958 from figure 1 have been superimposed (double track lines) on the proper chart for comparison.

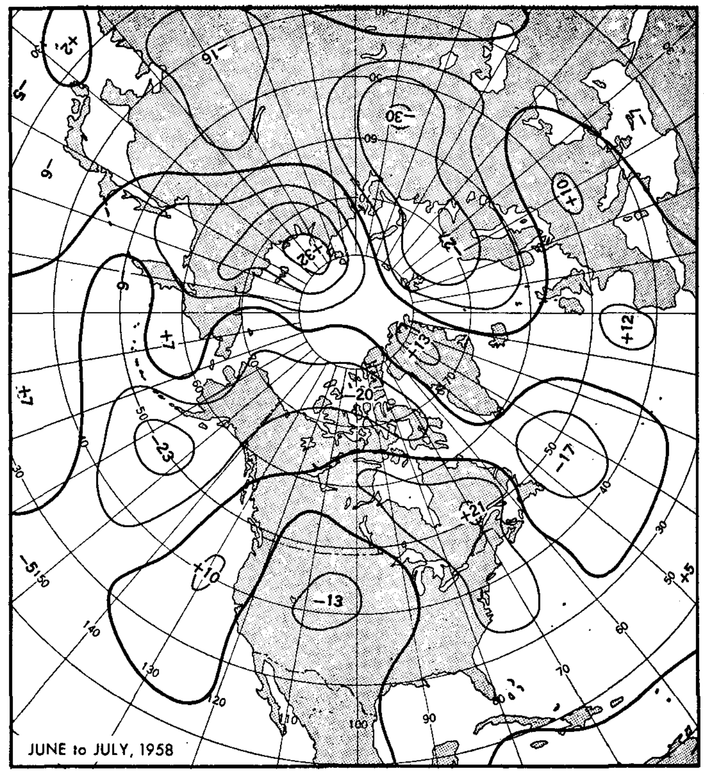


FIGURE 3.—Difference between monthly mean 700-mb. height anomaly for June and July 1958 (July minus June) in tens of feet. Anomalous falls in central United States were associated with the appearance of the abnormal trough in that area.

and the secondary one existed for only approximately one week beginning immediately after the middle of July. It should be emphasized that a complete reversal of the flow pattern did not take place, and the circulation was never completely divorced from the primary pattern. The flow remained cyclonic over the North Central States; the west coast trough was always weak, especially in the north, and cyclonic flow persisted in the eastern Bering Sea even during the secondary regime when a mean trough was observed in the western Bering Sea.

One of the most interesting aspects of the primary regime is the unusual location for this time of year of the majority of the 5-day mean troughs. This, of course, is consistent with the statements made earlier concerning the 30-day mean troughs. The investigation by Klein and Winston [2] further showed that 5-day mean troughs, as well as 30-day mean troughs, occur in climatologically preferred regions (fig. 7A). To show the persistent aspect of the abnormality of the mean circulation, the geographical frequencies of occurrence of 5-day mean troughs this July were computed and are displayed in a manner identical to that used in the aforementioned study (fig. 7B). Troughs were counted which appeared on the twelve 5-day mean charts for July that are routinely computed three times per week and centered two or three days apart. The normally high frequency of occurrence over New England and along the east coast of the United States was supplanted this July by maxima in adjacent areas, namely the eastern Atlantic and central United States. The latter was a significant departure from recent years. Equally anomalous were the high trough frequency in the

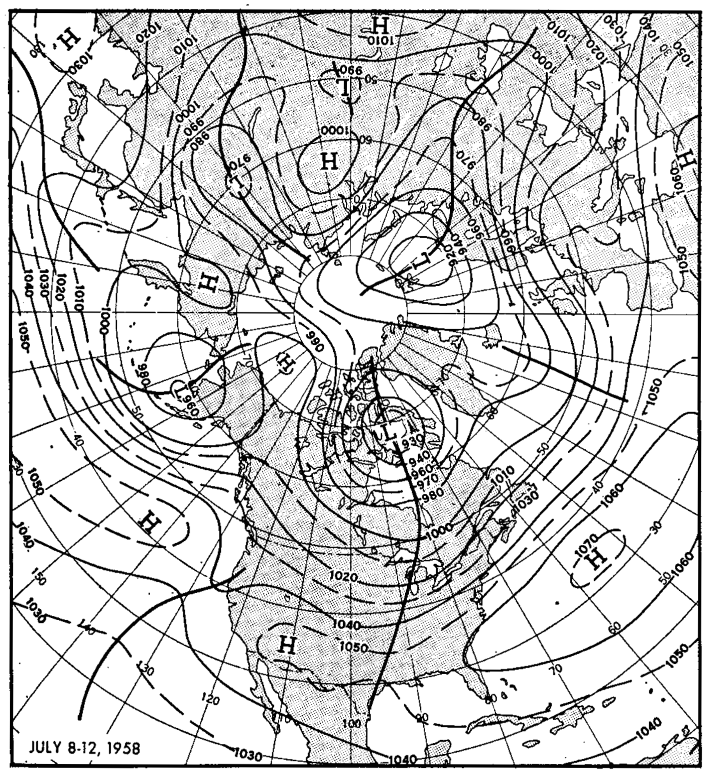


FIGURE 4.—5-day mean 700-mb. contours in tens of feet for July 8–12, 1958. The trough in central United States was a characteristic of the primary regime of July.

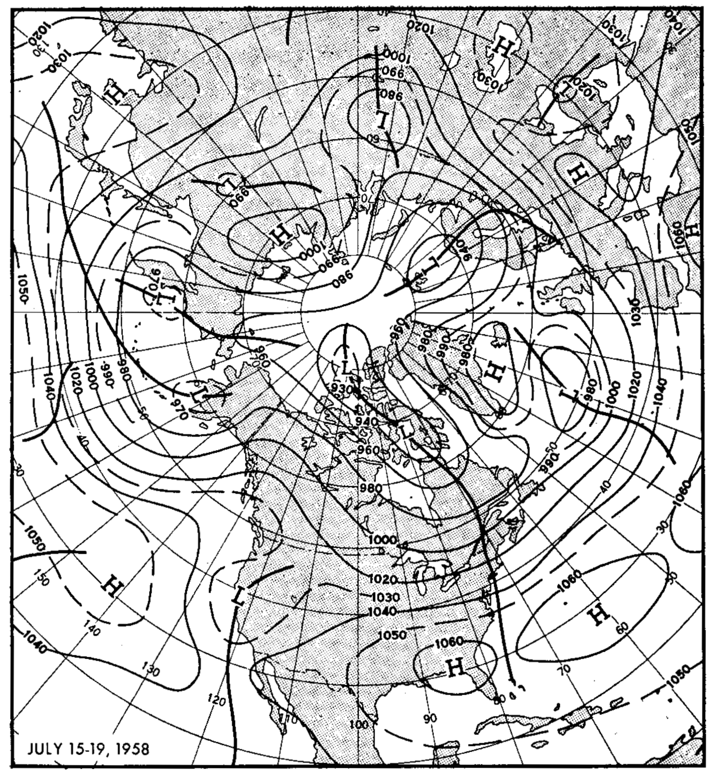


FIGURE 5.—5-day mean 700-mb. contours in tens of feet for July 15–19, 1958. This chart is typical of the secondary regime of July—troughs observed along the coasts but not in central United States.

eastern Bering Sea and southward into the central Pacific, and also the sharp maximum at 60° N. latitude between 120° E. and 130° E. longitude. Some of the troughs were located in favorable areas. For example, the California trough, although weak, was observed on most 5-day mean charts, and the occurrence of troughs in the western Bering Sea primarily during the secondary regime is discernible in the frequency chart.

It is of interest to seek out "teleconnections," or spatial relationships, between features of the circulation. During July 1958 there was a strong suggestion that the high incidence of troughs at 50°—60° N. latitude between 120° and 130° E. longitude, an unfavorable area in recent years for troughs, played an important role in forming the abnormal pattern downstream. In accordance with the familiar wavelength considerations and spatial distribution of percentage frequency of sign of height anomalies [3], troughs and subnormal heights in this area supported troughs located downstream in the *eastern* Bering Sea rather than in the more favored western section of the Sea near Kamchatka. In turn, the eastward displacement of the Bering Sea trough suppressed the trough along the west coast of the United States and supported cyclonic activity in central United States. Inspection of the series of 5-day mean 700-mb. charts for July 1958 revealed that in every case the trough in the western Bering Sea occurred only when the trough at 120°—130° E. filled as the Siberian blocking High shifted

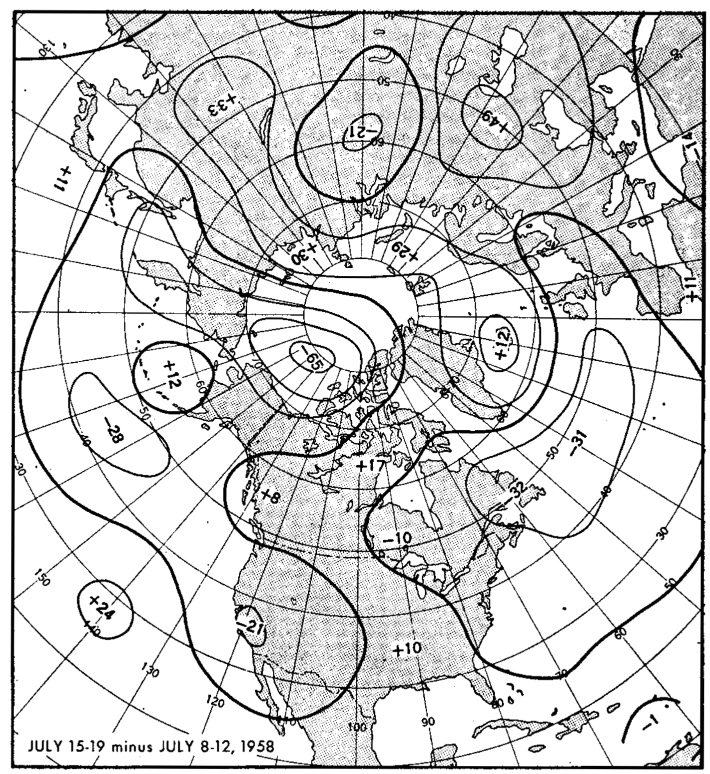


FIGURE 6.—Height difference between the 5-day mean charts for July 8–12 (fig. 4) and July 15–19, 1958 (fig. 5) (July 15–19 minus July 8–12) in tens of feet. Isoline interval is 200 feet. Heights increased in central United States but decreased in the East and West as the circulation changed to a pattern more typical of summer.

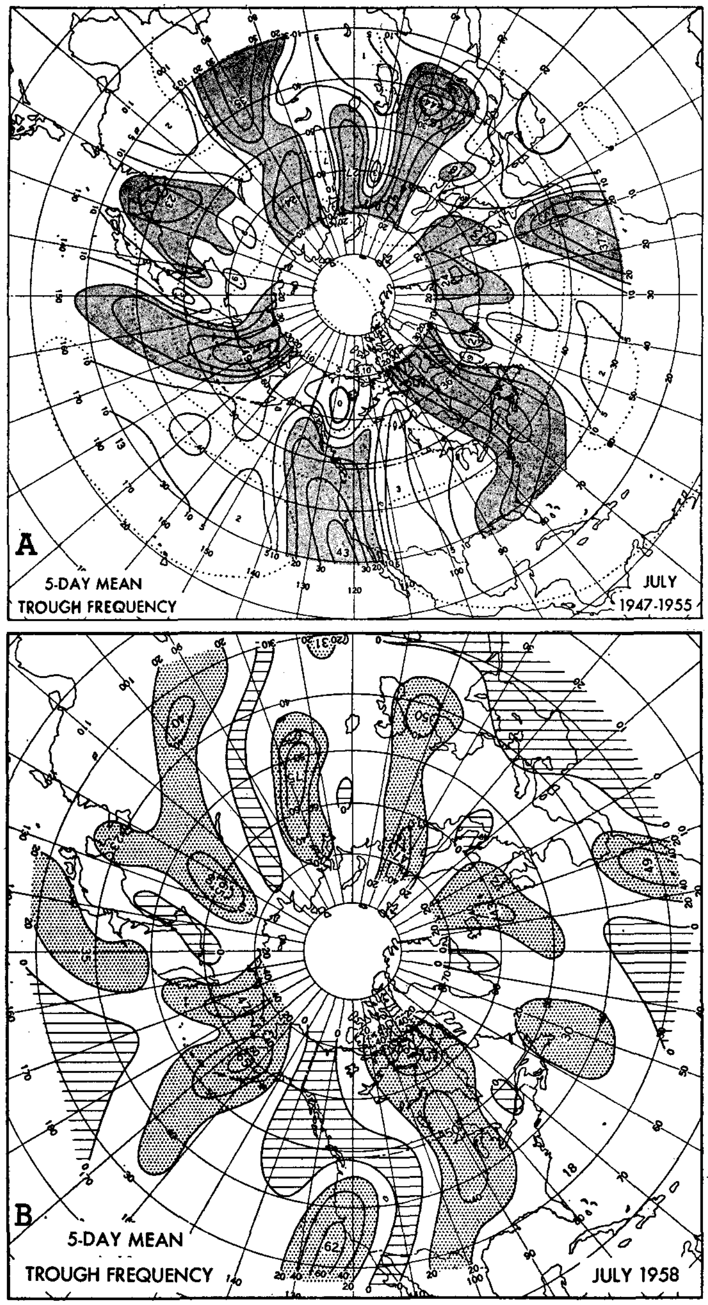


FIGURE 7.—(A) Percent of the time that troughs on 5-day mean 700-mb. charts were located within 10° longitude intervals at latitudes from 30° N. to 70° N. for July for period 1947 to 1955. The data were adjusted to an equivalent basis with 10° at 50° N. as the unit. The lines of equal frequency are drawn at intervals of 5 percent (except 10 percent for frequencies above 20 percent), with the zero line heavier. Areas with frequency greater than 15 percent are shaded. The light dotted lines are the contours of the normal chart for July. (B) Same as (A) but for July 1958. Isoline interval is 20 percent. Areas with frequency greater than 20 percent are stippled; zero areas are hatched. Note unusual high frequency of 5-day mean troughs in central United States.

eastward. Thus the abnormal location of the trough in central United States was associated with equally abnormal positions of the troughs upstream.

3. 30-DAY MEAN WIND FIELD

At the 700-mb. level the jet stream was well organized over the Western Hemisphere (fig. 8), but not over Eurasia. In the former region its axis had larger amplitude, i. e., meandered farther to the north and south, than the normal jet stream for July (dashed line in fig. 8). In the central Pacific the well-defined jet axis was south of normal, but it turned abruptly northward and passed over northwestern Canada before dipping sharply southward to subnormal latitudes again over eastern United States and the Atlantic, where blocking dominated.

The two principal wind speed maxima were found in the abnormally located oceanic troughs which were deep in the north but were unable to penetrate to the south because the zonally oriented subtropical ridges remained strong (fig. 1). The resultant intense height gradients supported wind speeds 3 to 7 m. p. s. above normal (fig. 8B) in these jet maxima.

Similarly in the United States the stream of westerlies flowing southward through the trough, located where ridges are more commonly found, resulted in supernormal winds over most areas of the central and eastern States.

Weaker than normal winds in the northeastern Atlantic were a manifestation of the blocking in that area. And subnormal wind speeds over northwestern United States, associated with the weaker than normal trough in that area, were noteworthy for their pronounced effect on the local weather (see section 5).

4. AIRMASSES AND DAILY FRONTAL POSITIONS

The planetary wave of large amplitude centered over western North America resulted in frequent advection of cool, polar airmasses into the central United States, and the temperature of the lower layers of air averaged below normal in this area during July (fig. 9). Several Highs had tracks extending from western Canada into the northern Plains and then eastward across United States (Chart IX). The frequency of anticyclone passages was computed (within 5° latitude-longitude "boxes" at 45° N.) for July 1958 over the Western Hemisphere, and seven Highs, the maximum for the entire area, passed through the box centered over Lake Michigan. The pronounced 700-mb. ridge in the West and the weak ridge in the East were attended by warm air masses and few anticyclonic centers at sea level.

Since the cool airmasses repeatedly penetrated unusually far south in central United States, an active frontal zone was frequently located at rather low latitudes for July along an east-west band from the Middle Atlantic States to the southern Rocky Mountain States (fig. 10). Quite often in July, fronts remain farther north than this along the northern tier of States. This

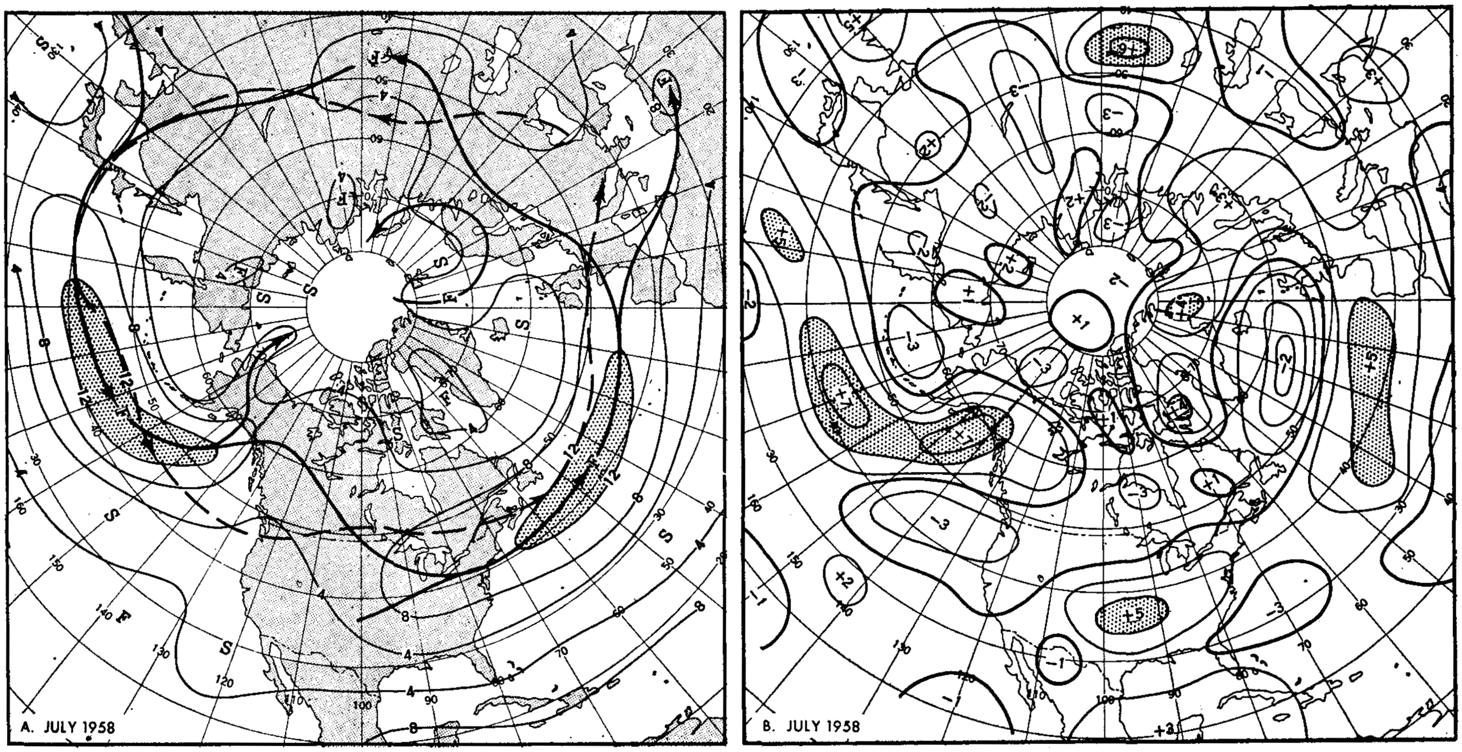


FIGURE 8.—(A) Mean 700-mb. isotachs and (B) departure from monthly normal wind speed (both in meters per second) for July 1958 Solid arrows in (A) indicate principal areas of maximum winds and dashed arrows their normal July positions. Regions with speeds greater than 12 m. p. s. have been stippled. Jet maxima were located over the Pacific and Atlantic oceans, and wind speeds were above normal over central and eastern United States.

July, fronts were observed on 15 or more days in the middle latitudes of the United States, with an extreme of 24 days with fronts in the Kansas-Missouri region.

This month we had an excellent illustration of the expected simultaneous relationship of several meteorological parameters. Extending from the central United States to the Northeast, there existed a confluence zone (fig. 1) and jet stream with attendant super-normal winds (fig. 8). Associated with these circulation features were a strong north-south temperature gradient (fig. 9) and narrow band of high frequency of days with fronts (fig. 10) Along this active zone, showers were frequent, and the total precipitation for the month was large.

5. WEATHER OF THE MONTH

PRECIPITATION

July was a wet month over most of the United States (Chart II, Chart III A, B). Vast areas received more than the normal amount, and some regions reported 3 to 5 times the usual July rainfall (Chart III–B). In the central areas of the United States and in the Northeast extreme amounts from 5 to 15 inches (Chart II) established many new station precipitation records. No less than eleven stations in this area, which have long periods of record, reported all time high precipitation amounts for July (table 1). Springfield, Mo. and Parkersburg, W. Va. even had their wettest calendar month on record. Other stations, although not reporting record-breaking amounts, had more rainfall than any July in recent years—many since the turn of the century (table 2). The inclusion of Billings, Mont., in table 2 indicates the heavy precipitation regime which occurred in parts of the northern Rocky Mountain States. This July's heavy rainfall, besides being associated with the abnormally cyclonic flow, confluence, jet stream, and frequent fronts over central areas of the United States, was also

TABLE 1.—*New precipitation records made in July 1958*

Station	Total monthly precipitation (inches)	Date records start
Lincoln, Nebr.	11.40	1878
Columbia, Mo.	11.45	1889
Springfield, Mo.	18.75	1887
Akron, Ohio	11.43	1887
Columbus, Ohio	10.07	1878
Toledo, Ohio	6.71	1870
Youngstown, Ohio	7.41	1942
Parkersburg, W. Va.	12.05	1888
Williamsport, Pa.	8.30	1873
Baltimore, Md.	11.50	1871
Nantucket, Mass.	7.45	1886
Tucson, Ariz.	5.20	1892
Mount Shasta, Calif.	1.77	1888

TABLE 2.—*Unusually large precipitation amounts for July 1958*

Station	Total July precipitation	Latest previous year with larger amount
Billings, Mont	3.12	1912
Duluth, Minn	8.51	1909
Omaha, Nebr	9.60	1875
Valentine, Nebr	5.39	1929
Peoria, Ill	8.42	1860
Evansville, Ind	9.69	1910
Indianapolis, Ind	8.11	1875
South Bend, Ind	7.18	1896
Lexington, Ky	10.64	1875
Louisville, Ky	7.05	1922
Charleston, W. Va	9.36	1938
Columbia, S. C	8.70	1936
Washington, D. C	7.15	1945
Middletown, Conn	8.14	1938
Providence, R. I	6.29	1938

enhanced by the stronger than normal Bermuda High (fig. 1 and Chart XI) which produced abnormally strong southerly flow of moist tropical air from the Gulf of Mexico northward over much of the eastern two-thirds of the country.

In southern Arizona pronounced shower activity produced above normal rainfall (Chart III–B), and Tucson reported the wettest July on record. Northern California and southern Oregon, usually dry at this time of year, had precipitation totaling more than one inch. Mount Shasta, Calif., established a new July record of 1.77 inches.

Because of the highly favorable regime for rainfall, dry conditions were reported from only small areas in the United States. The extreme west coast where downslope flow prevailed (note anomalous flow from northeast in fig. 1), received little or no rainfall. Seattle, Wash., with no measurable precipitation, had the driest July on record, and Tatoosh Island, Wash., measured only 0.24 inch, their smallest amount since 1922. A large area of the Great Basin was also arid, but there was no organized drought in the United States. The few stations that did report record dry weather were widely scattered. In addition to those stations already mentioned, Winslow, Ariz. with 0.17 inch and Cape Hatteras with 0.45 inch reported the driest July on record. Grand Junction, Colo., and Albuquerque, N. Mex, had their driest July since 1898 and 1900 respectively. Over the United States as a whole there was a paucity of significant dry-weather reports, but many precipitation and cloudiness records were broken, and July 1958 will be recorded as an extremely wet month in most areas.

TEMPERATURE

In the central portion of the United States, where the heavy rainfall was noted, temperatures averaged very cool for July. However extreme southern parts of the Plains, and Rocky Mountain States were warm with some areas reporting much-above normal temperatures (Chart I). Hot weather also was observed in the Far Northwest,

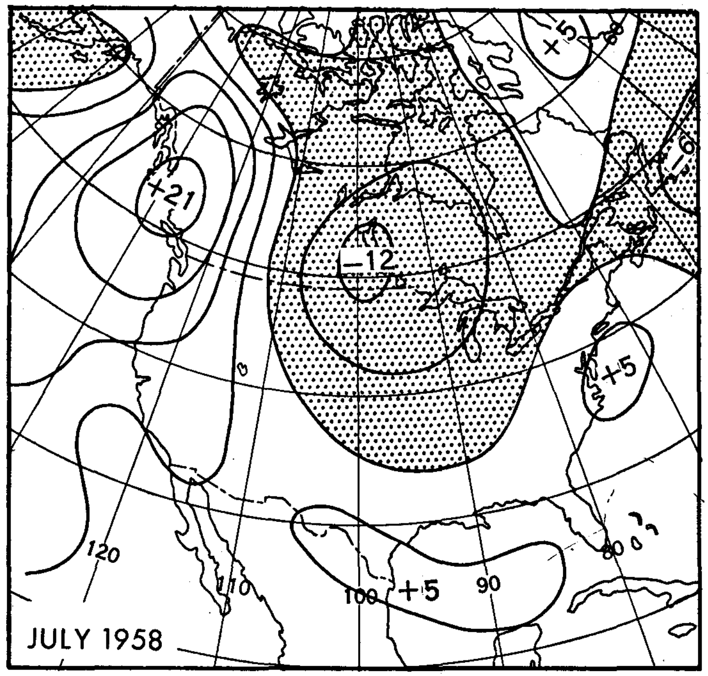


FIGURE 9.—Departure from monthly normal of the mean thickness (700–1000 mb.) for July 1958 (in tens of feet). Isoline interval is 50 feet. Below normal values are stippled. Cool conditions dominated the central United States while warm airmasses occupied the Northwest and Southeast.

in coastal regions of California, and in the Middle and Southern Atlantic States.

From June [5] to July there was a westward shift of the temperature pattern, associated with the retrogression of the planetary trough from the east coast to the central United States. In the central Plains and Rocky Mountain States temperatures cooled by 2 to 3 classes from June to July, while an equal amount of warming took place in the Middle Atlantic States (fig. 11). Little change occurred in between over the Central States where temperatures remained below normal.

This month's temperature pattern is, in most areas, easily related to the mean flow. The ridge with above normal heights in western Canada and the trough with subnormal heights over central United States (fig. 1) were accompanied by stronger than normal northerly flow over western North America. This encouraged frequent invasions of cool airmasses over the central Plains of the United States. The eastern ridge remained flat, especially in the north, under the domination of the Atlantic blocking, so that the cool airmasses frequently pushed eastward and kept northern New England cool.

The cool weather in States bordering the eastern Gulf of Mexico seemed to be associated with cyclonic flow at 500 mb. (not shown), and the cloudiness and precipitation which occurred in the first half of July.

In the Great Basin the subnormal temperatures, which have been so characteristic of Julys since 1953, are not easily explained. The records at Winnemucca and Ely, for example, indicate that both the maximum and minimum temperatures were below normal, while the amounts of cloudiness and sunshine were very close to normal. Precipitation could not have suppressed the temperatures since it was below normal, and in fact the warmest and cloudiest days tended to occur together. The California trough was weak, and there was little advection of cool Pacific air into the Basin. The 700–1000-mb. thickness averaged above normal (fig 9). However, at 700 mb. the anomalous flow was from the north-northeast (fig. 1), indicating that on the average cooler than normal air was advected into this area at the higher levels. This cool air aloft could have maintained a steep lapse rate, thus holding the surface temperatures below normal. But this seems hardly an adequate explanation for the much below normal temperatures that were observed. An extreme of $-6.1°$ at Winnemucca is over three times the standard deviation—a rare event indeed. Perhaps these extreme anomalies are tied in with the currently used normal temperature.

Temperatures in the Great Basin have been cool, relative to surrounding areas, since 1953 when the normal temperatures were adjusted for different periods of record, changes of station locations, etc. Because past records have been so heterogeneous, establishing the proper normal is a very difficult problem. Therefore, it is possible that the negative anomalies during recent Julys in this area are partially a result of the new normal temperatures, which are higher than those used prior to 1953. For example, the July normal temperatures used after 1952 were higher than the previous normals by 3.6° F. at Winnemucca, Nev., 4.9° F. at Ely, Nev. 3.4° F. at Las Vegas, Nev., and 3.8° F. at Yuma, Ariz. At neighboring stations the normals also increased but by smaller amounts. After checking the records at a few of these pertinent stations it was found that the monthly mean temperature anomaly at Winnemucca has been negative every July since 1953 and also negative at Ely since 1955. For every 5-day period during July 1958 the anomaly at Winnemucca was negative, and at Ely the anomaly reached $+1$ for only two 5-day periods, which, incidentally, were overlapping.

Admittedly certain regimes are known to persist for considerable lengths of time, and the cool weather relative to past years in the Great Basin may be entirely real or at least partly so. But the associated circulation anomalies (incidentally based on normals for a different period than the temperature normals) for this July do not support the extreme temperature anomalies in that area. More light will probably be shed on this problem when new normals are computed in 1960.

The warmth in the Middle Atlantic States was associated with the persistent Bermuda High and southerly anomalous flow at sea level (Chart XI) and at 700 mb. (fig. 1). The only time cool, dry air really penetrated this area was during the secondary regime (fig. 5) immediately after mid-month. In the Northwest the strong ridge (fig. 1), with absence of westerlies (fig. 8), and accompanying cool Pacific airmasses, prolonged the record-breaking heat wave previously reported in June [5]. Olympia and Seattle, Wash., and Eugene and Pendleton, Oreg. had the warmest July on record.

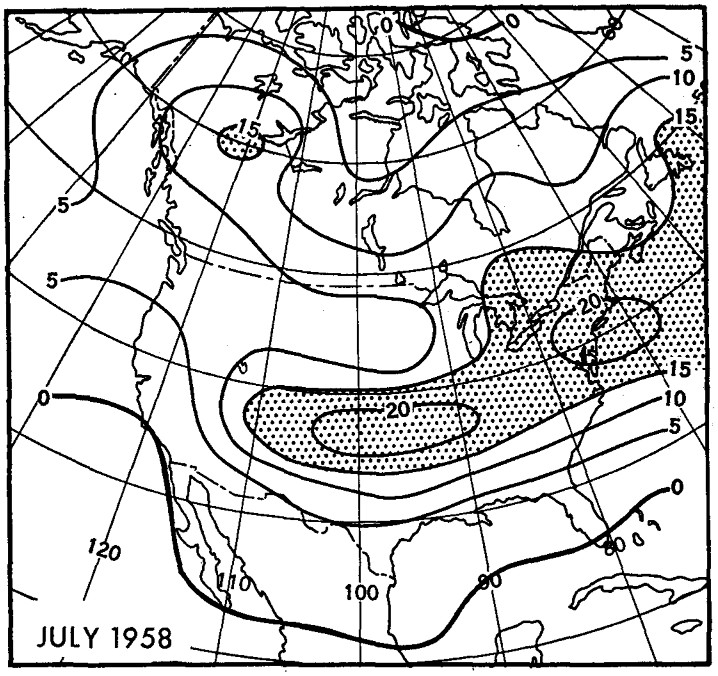


Figure 10.—Number of days in July 1958 with fronts of any type within unit squares (with sides approximately 500 miles). All frontal positions are taken from *Daily Weather Map*, 1:00 p. m., EST. Areas with 15 or more days with fronts are stippled. Fronts were frequently located in central and northeastern United States, separating the cool polar airmasses from the maritime tropical airmasses.

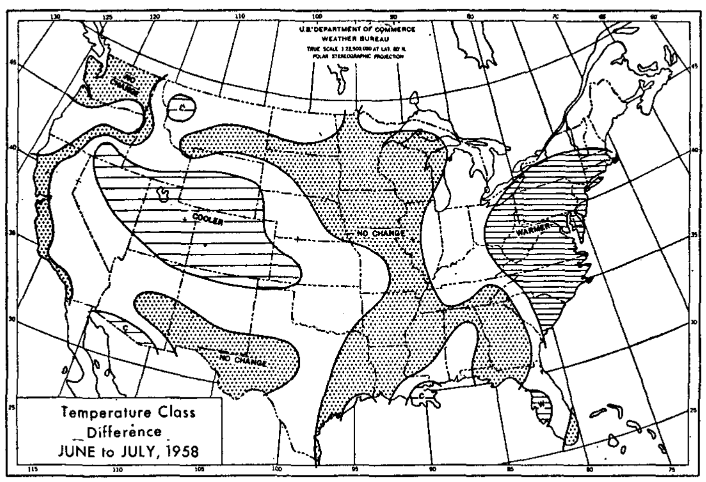


Figure 11 —Number of classes the anomaly of temperature changed from June to July 1958. Areas where the anomaly in July was 2 or 3 classes cooler are stippled, 2 or 3 classes warmer are fine hatched, and areas of no change in anomaly are coarse hatched. The East was warmer and the interior areas of the West were cooler in July than in June.

The long-period trend for the coast of California to be warm continued through this month, and San Francisco had the warmest July on record. This persistent anomaly was thoroughly investigated by O'Connor [5] in the previous article of this series, and it seems to be most closely allied with the abnormally warm sea-surface temperatures which minimize the cooling effect of the sea breeze.

6. TROPICAL STORMS

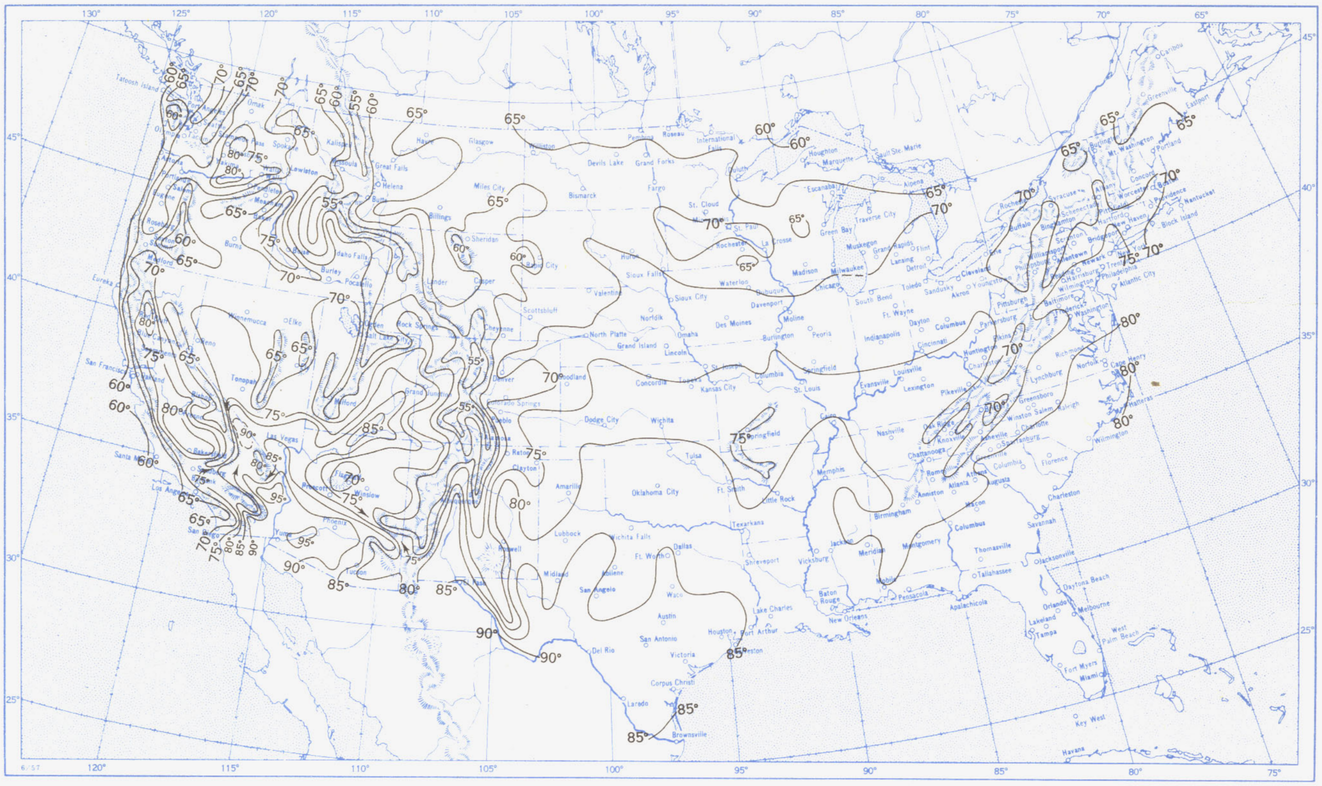
There were no tropical storms this July in the North Atlantic. Sea-surface temperatures were above normal, but the intense blocking over the Atlantic depressed the westerlies, and the circulation was highly unfavorable for tropical storms in that area [1, 4].

In the Pacific there was considerable tropical activity. Four storms occurred in the eastern Pacific between the Hawaiian Islands and the mainland of North America. Two of these cyclones reached hurricane intensity. In the western Pacific six tropical storms were reported, and all but one reached typhoon intensity.

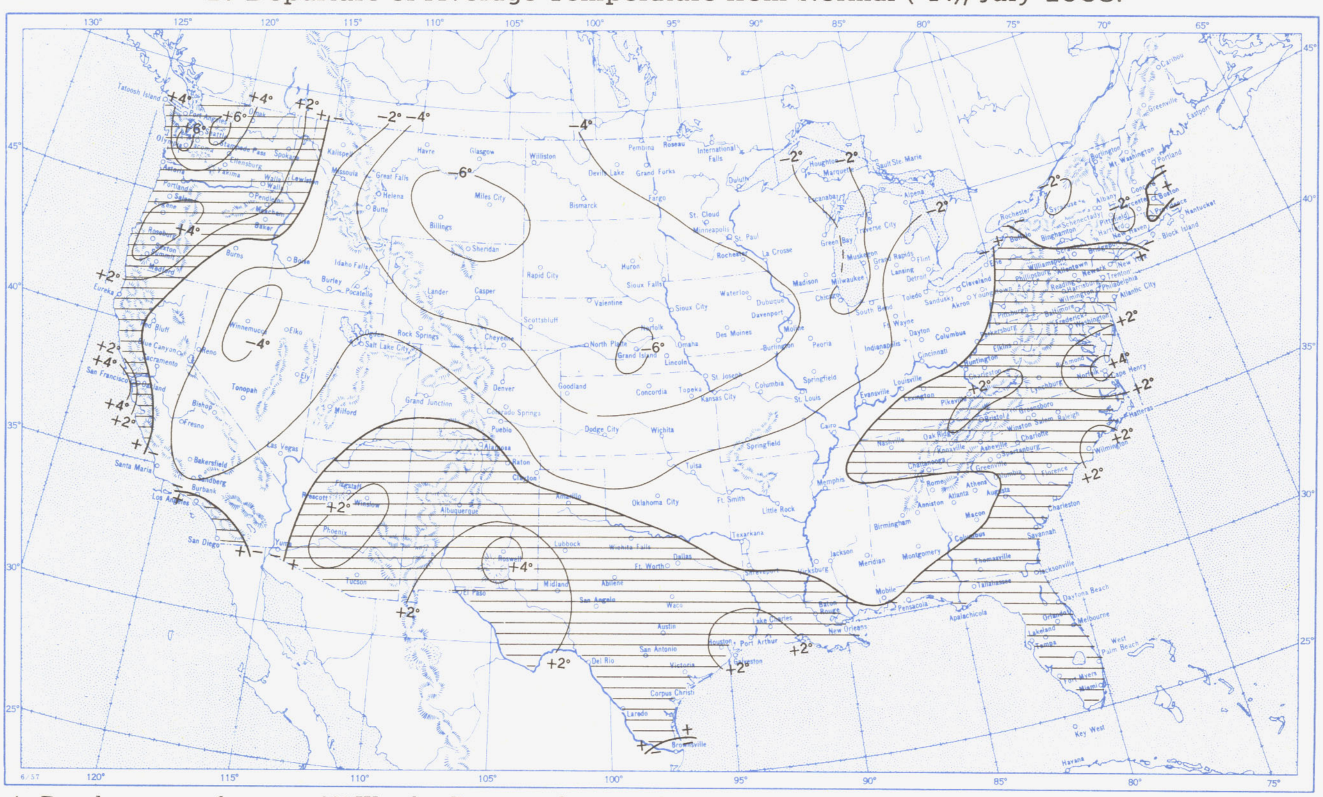
REFERENCES

1. E. M. Ballenzweig, "Relation of Long-Period Circulation Anomalies to Tropical Storm Formation and Motion," *Journal of Meteorology* (To be published).
2. W. H. Klein and J. S. Winston, "Geographical Frequency of Troughs and Ridges on Mean 700-mb. Charts," to be published in *Monthly Weather Review*, vol. 86, 1958.
3. [D. E. Martin], "Atlas of 700-mb. Five-Day Mean Northern Hemisphere Anomaly Charts," Air Weather Service, *Technical Report* No. 105–100/2, July 1955, 39 pp.
4. J. Namias, "Long-Range Factors Affecting the Genesis and Paths of Tropical Cyclones," *Proceedings, UNESCO Symposium on Typhoons, 9–12 November 1954, Tokyo*, pp. 213–219.
5. J. F. O'Connor, "The Weather and Circulation of June 1958—Record Cold in Northeast and Warmth in Northwest," *Monthly Weather Review*, vol. 86, No. 6, June 1958, pp. 229–236.

Chart I. A. Average Temperature (°F.) at Surface, July 1958.

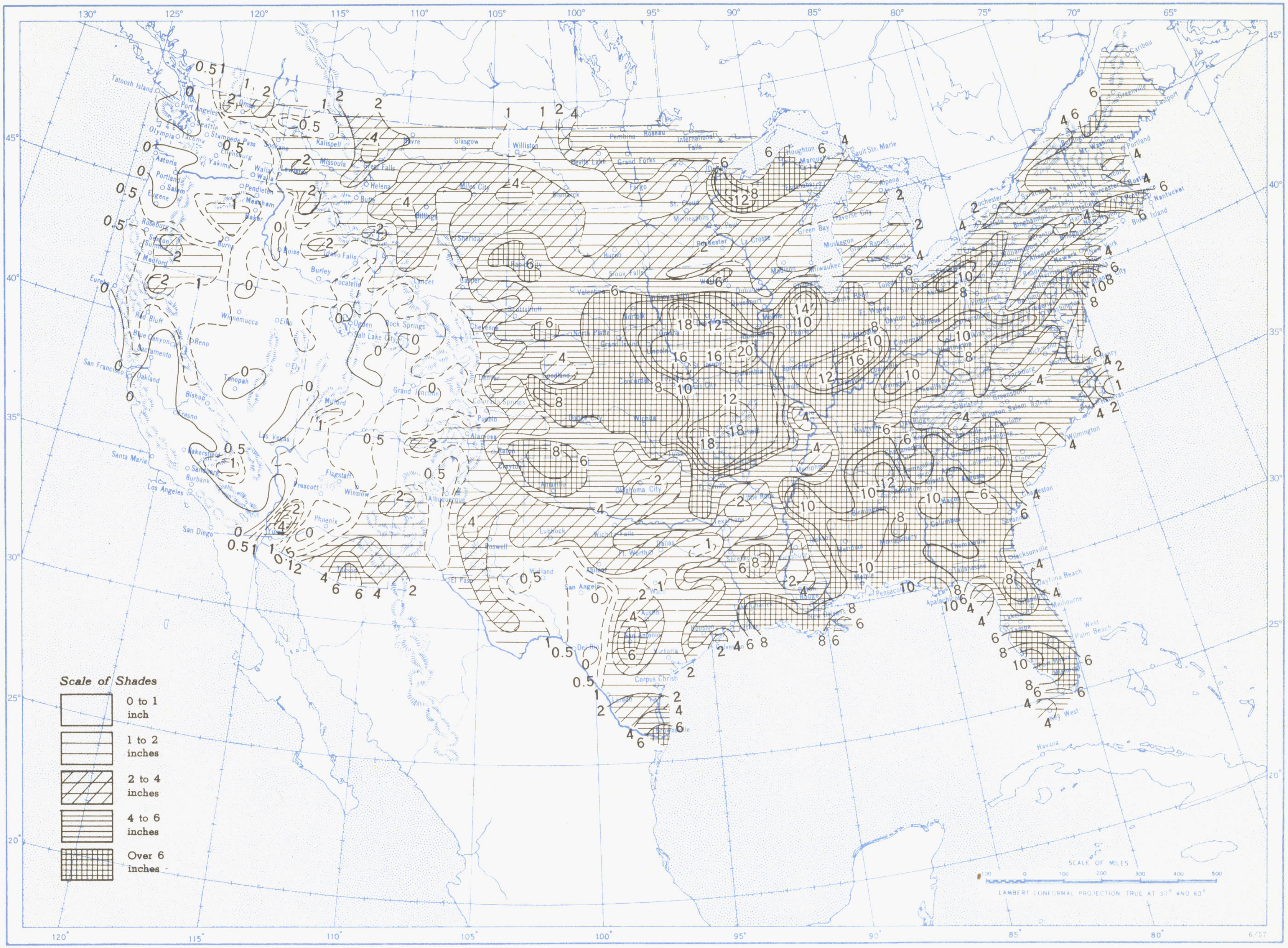


B. Departure of Average Temperature from Normal (°F.), July 1958.



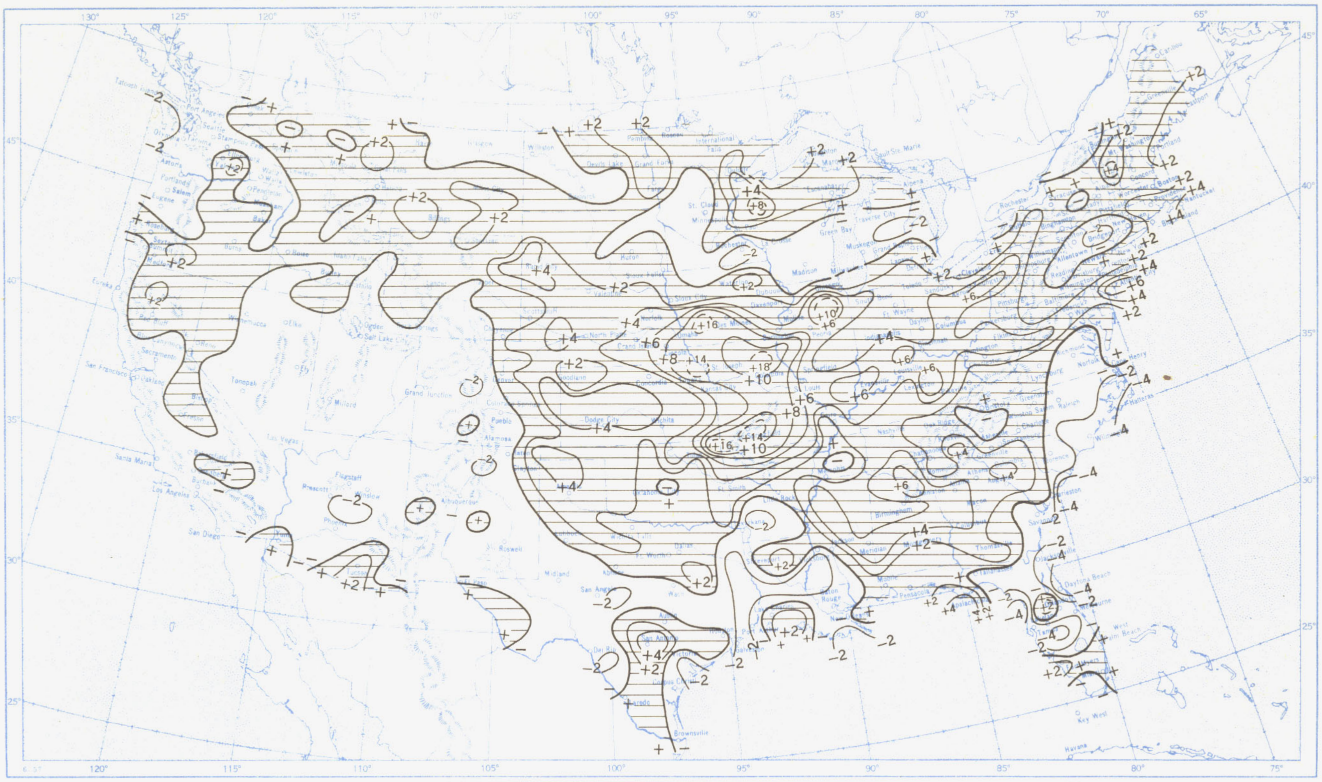
A. Based on reports from over 900 Weather Bureau and coöperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Departures from normal are based on the 30-yr. normals (1921-50) for Weather Bureau stations and on means of 25 years or more (mostly 1931-55) for coöperative stations.

Chart II. Total Precipitation (Inches), July 1958.

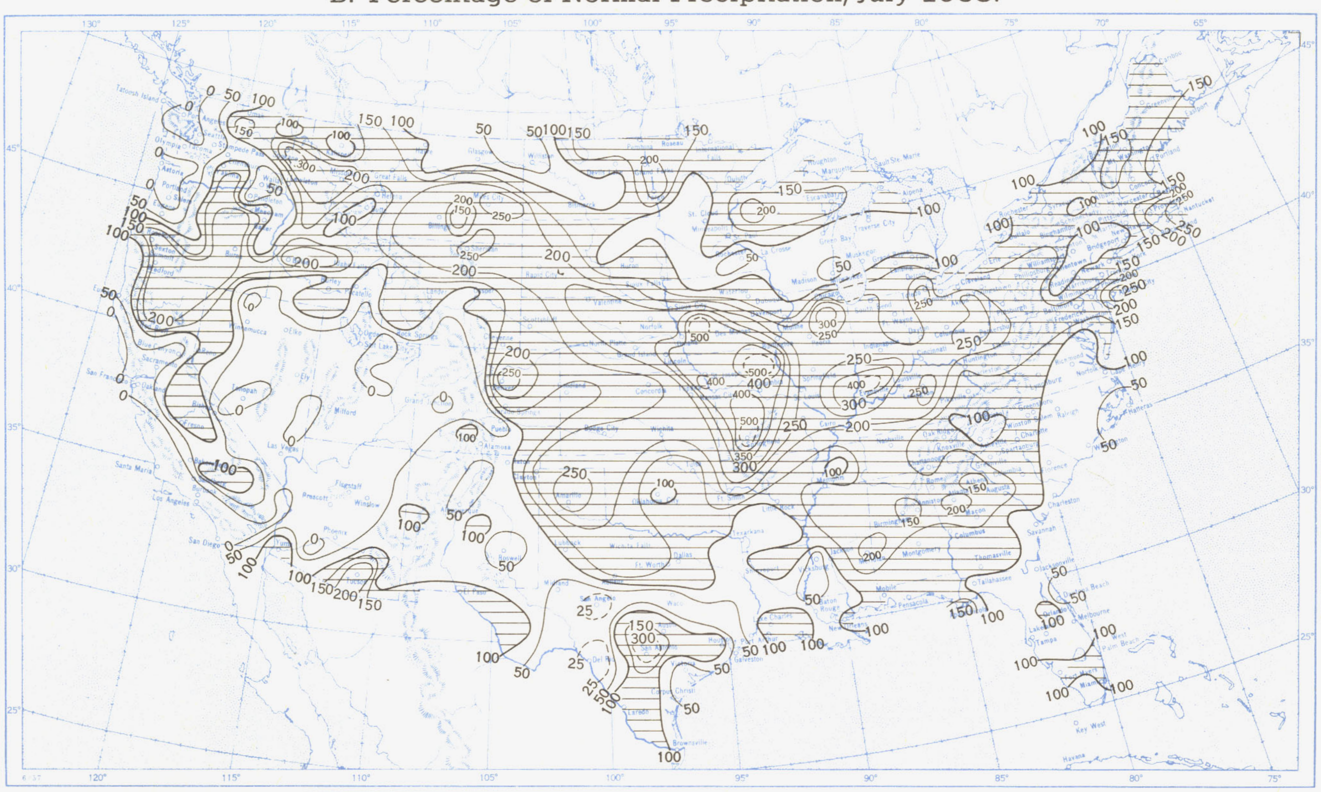


Based on daily precipitation records at about 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), July 1958.

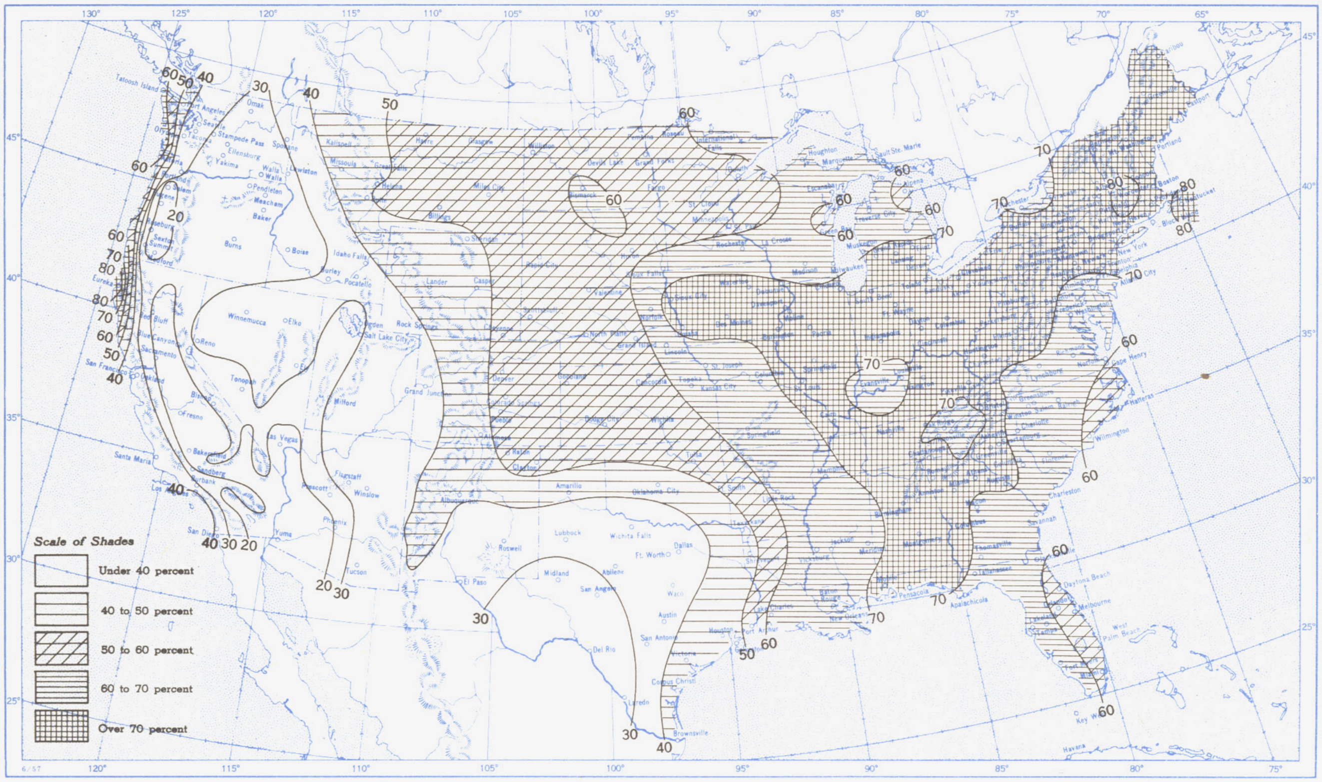


B. Percentage of Normal Precipitation, July 1958.

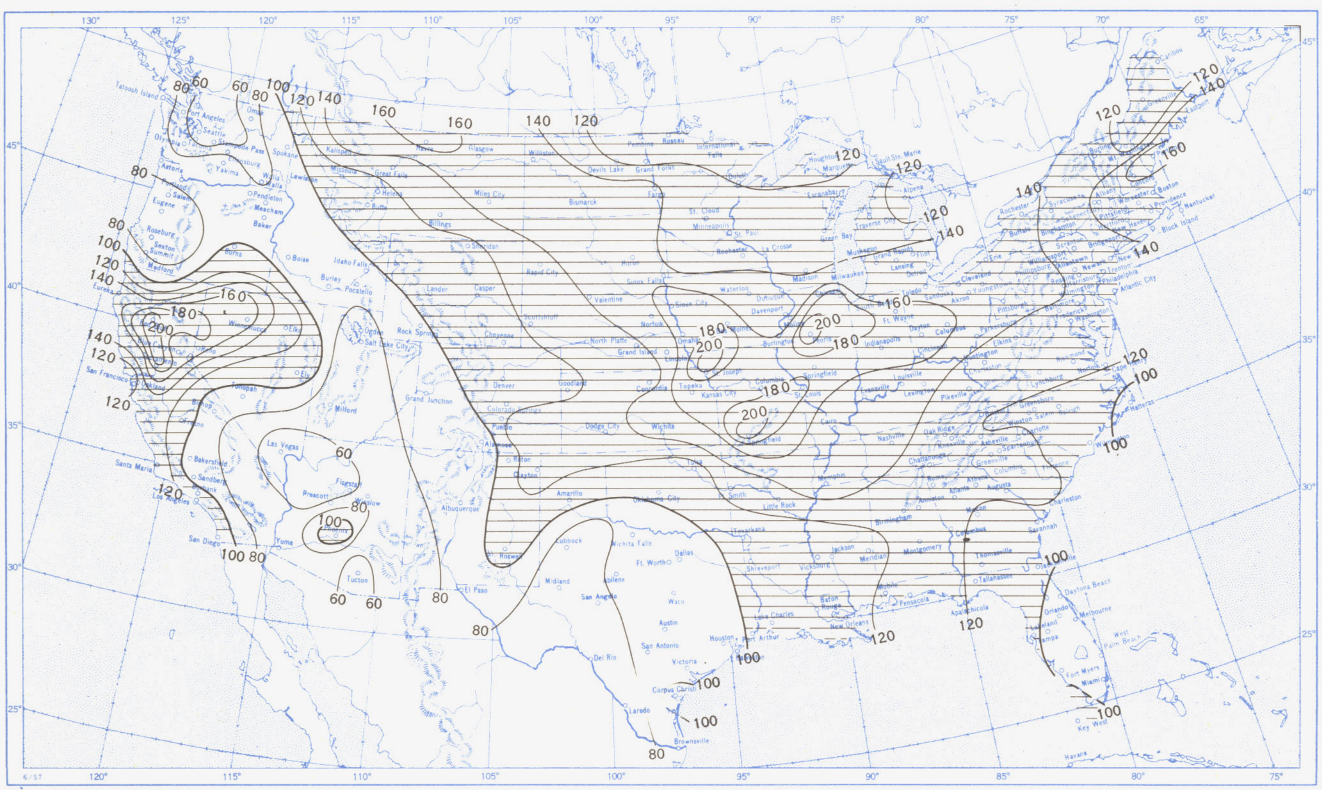


Normal monthly precipitation amounts are computed from the records for 1921-50 for Weather Bureau stations and from records of 25 years or more (mostly 1931-55) for cooperative stations.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, July 1958.

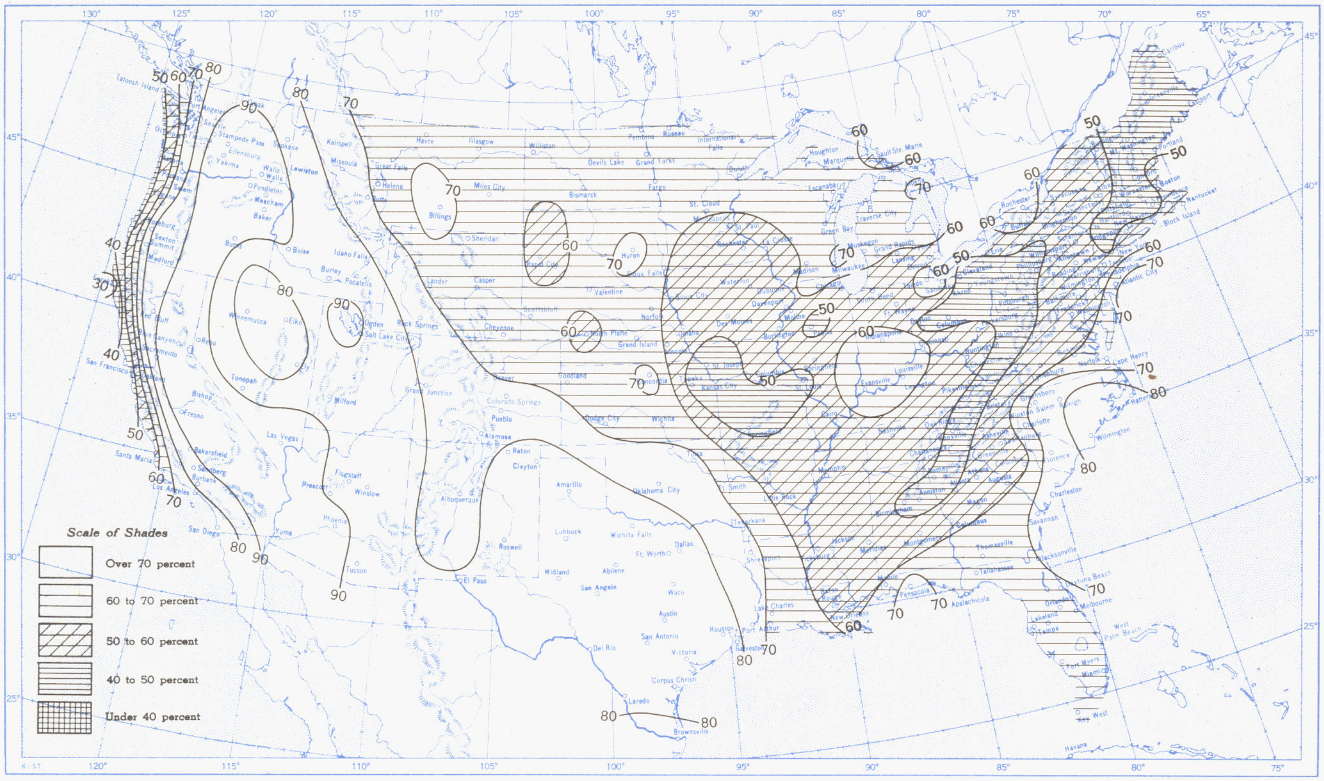


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, July 1958.

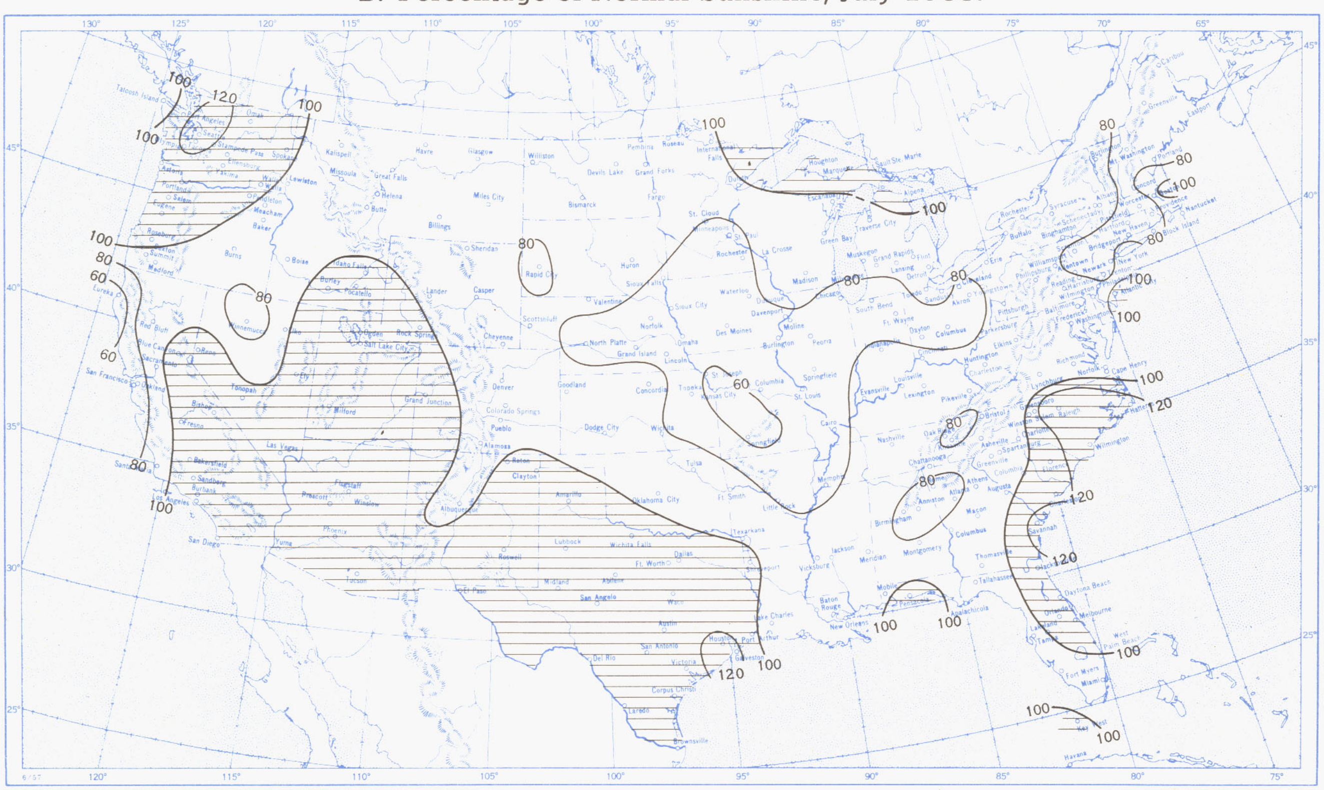


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, July 1958.



B. Percentage of Normal Sunshine, July 1958.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, July 1958. Inset: Percentage of Mean Daily Solar Radiation, July 1958. (Mean based on period 1951-55.)

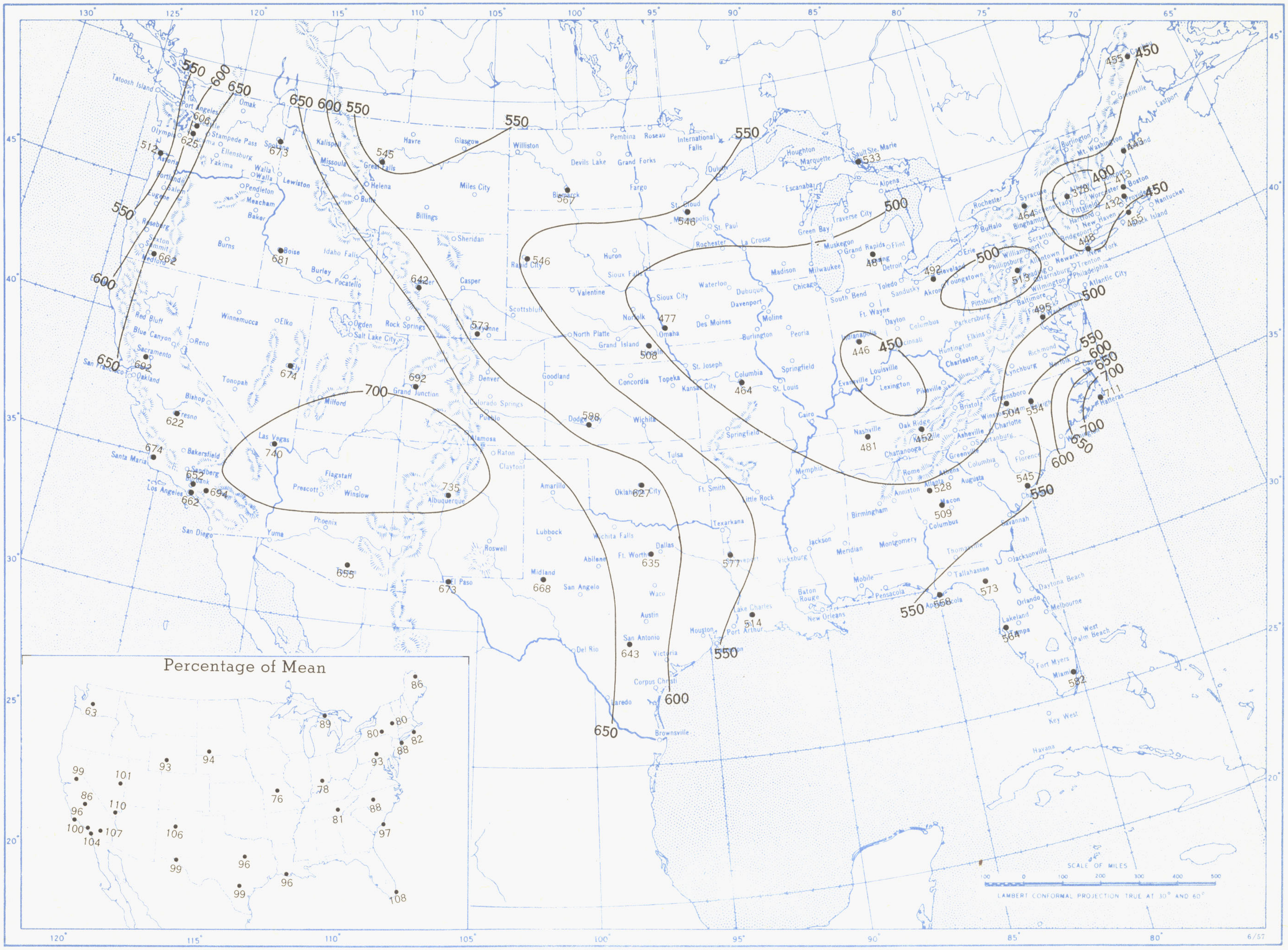
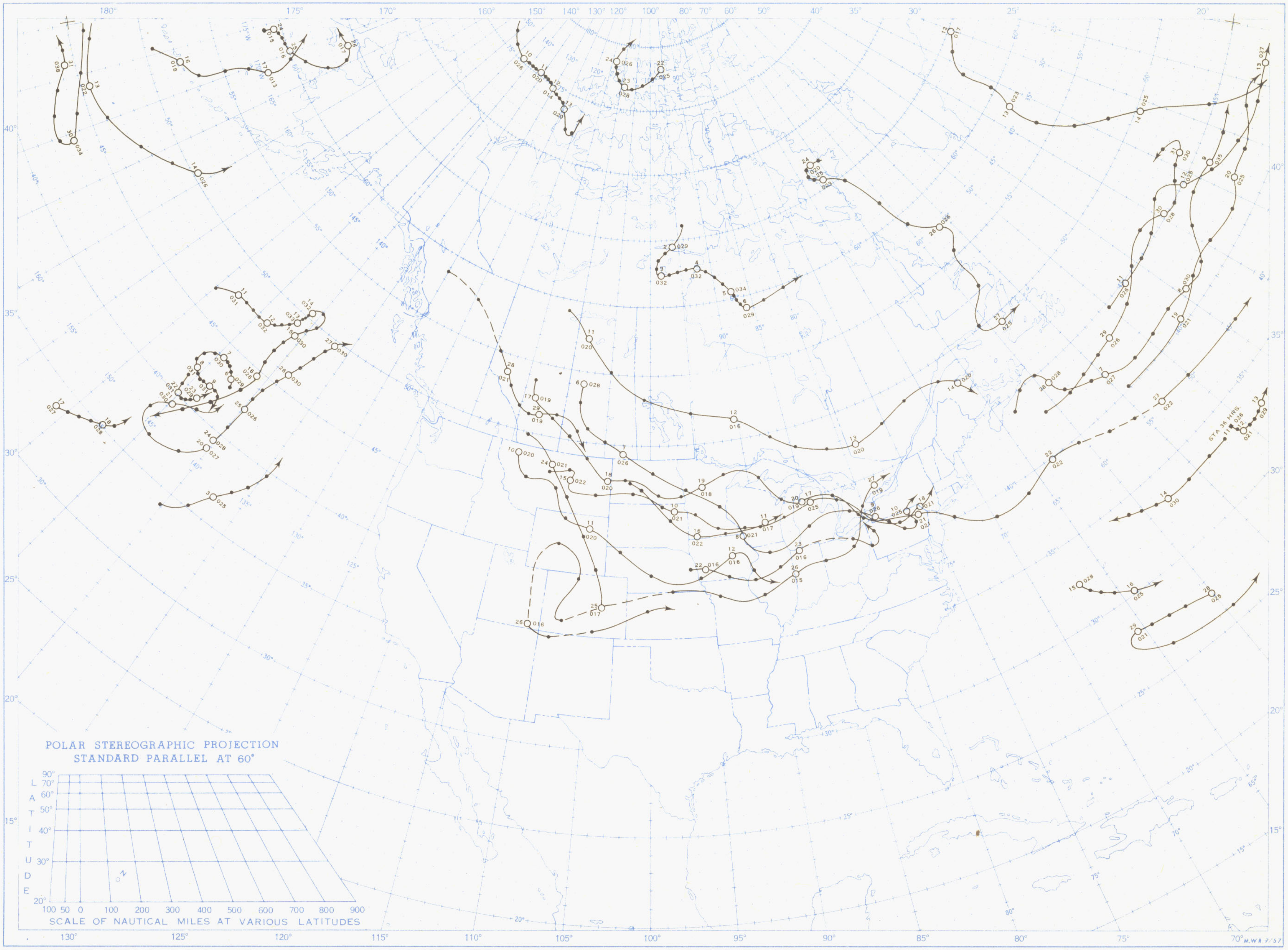


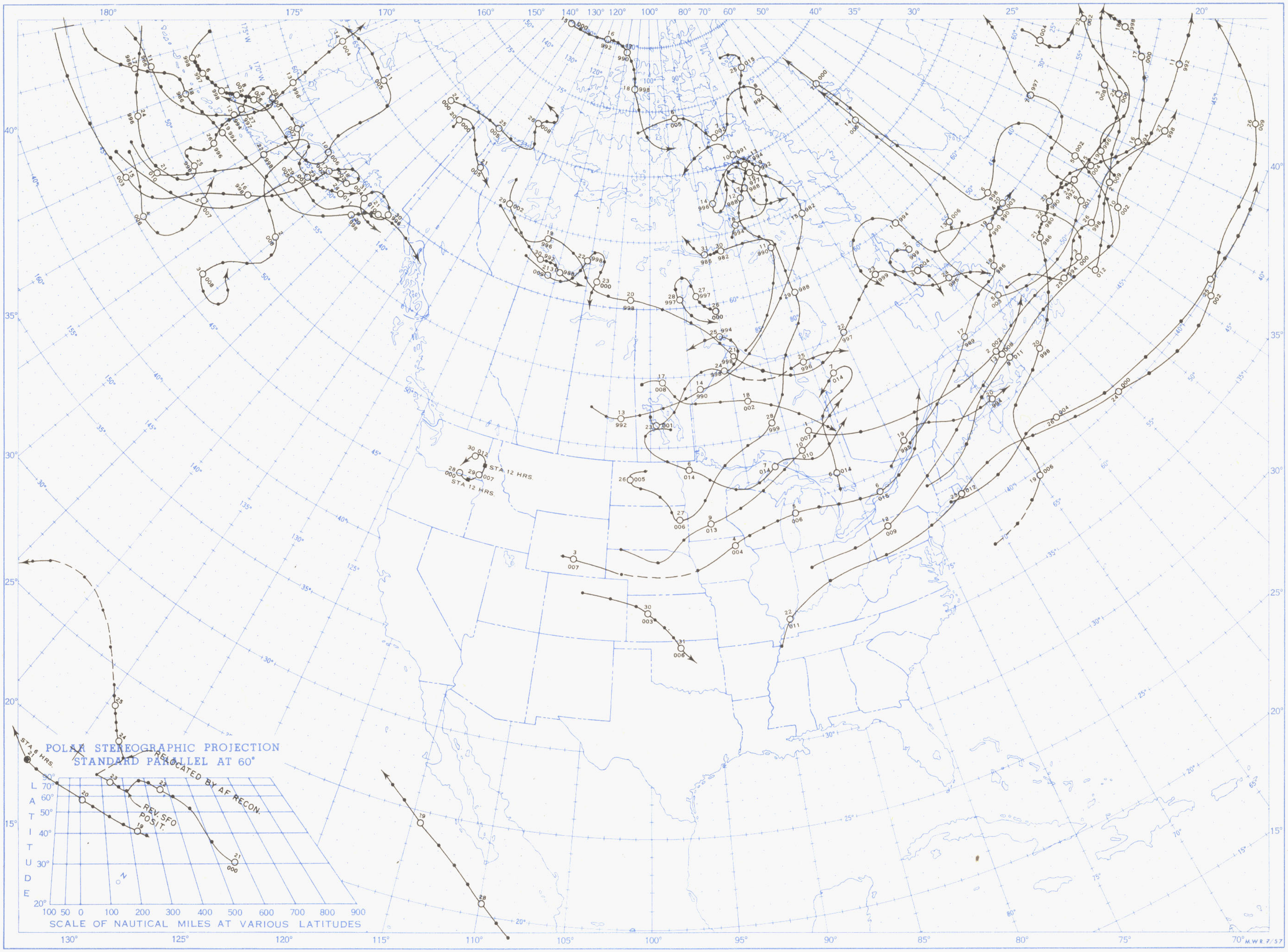
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. The inset shows the percentage of the mean based on the period 1951-55.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, July 1958.



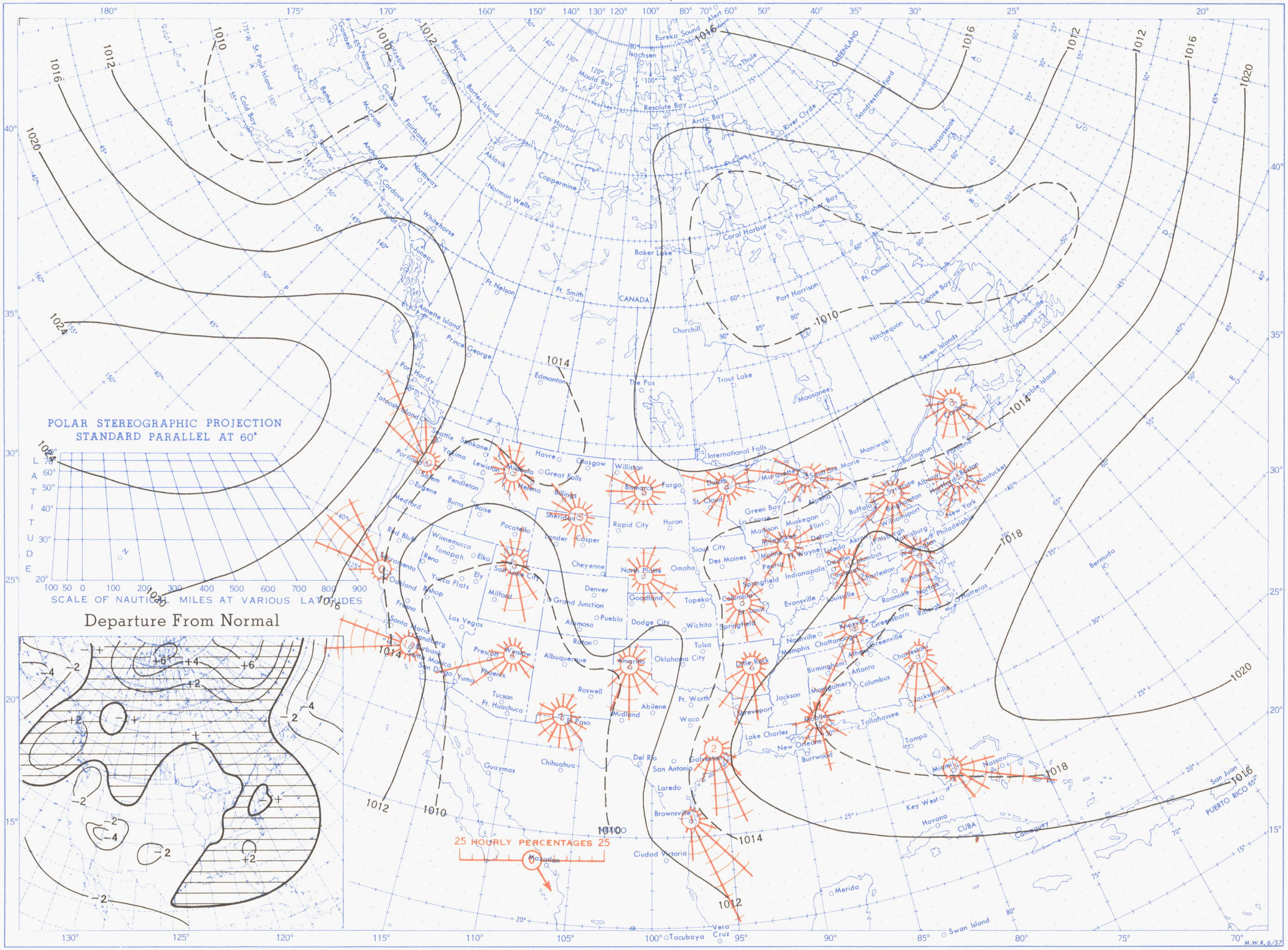
Circle indicates position of center at 7:00 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, July 1958.



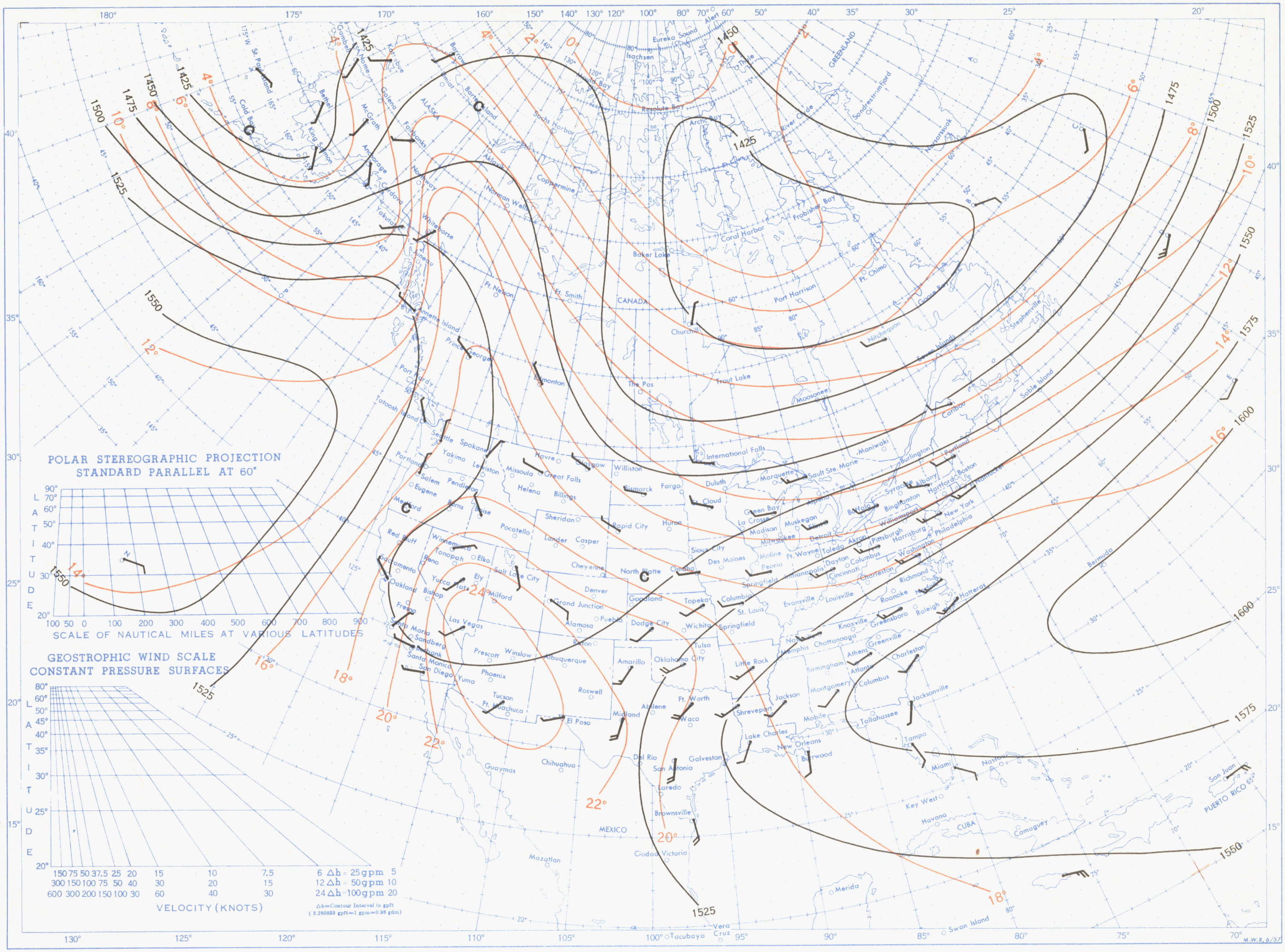
Circle indicates position of center at 7:00 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, July 1958. Inset: Departure of Average Pressure (mb.) from Normal, July 1958.



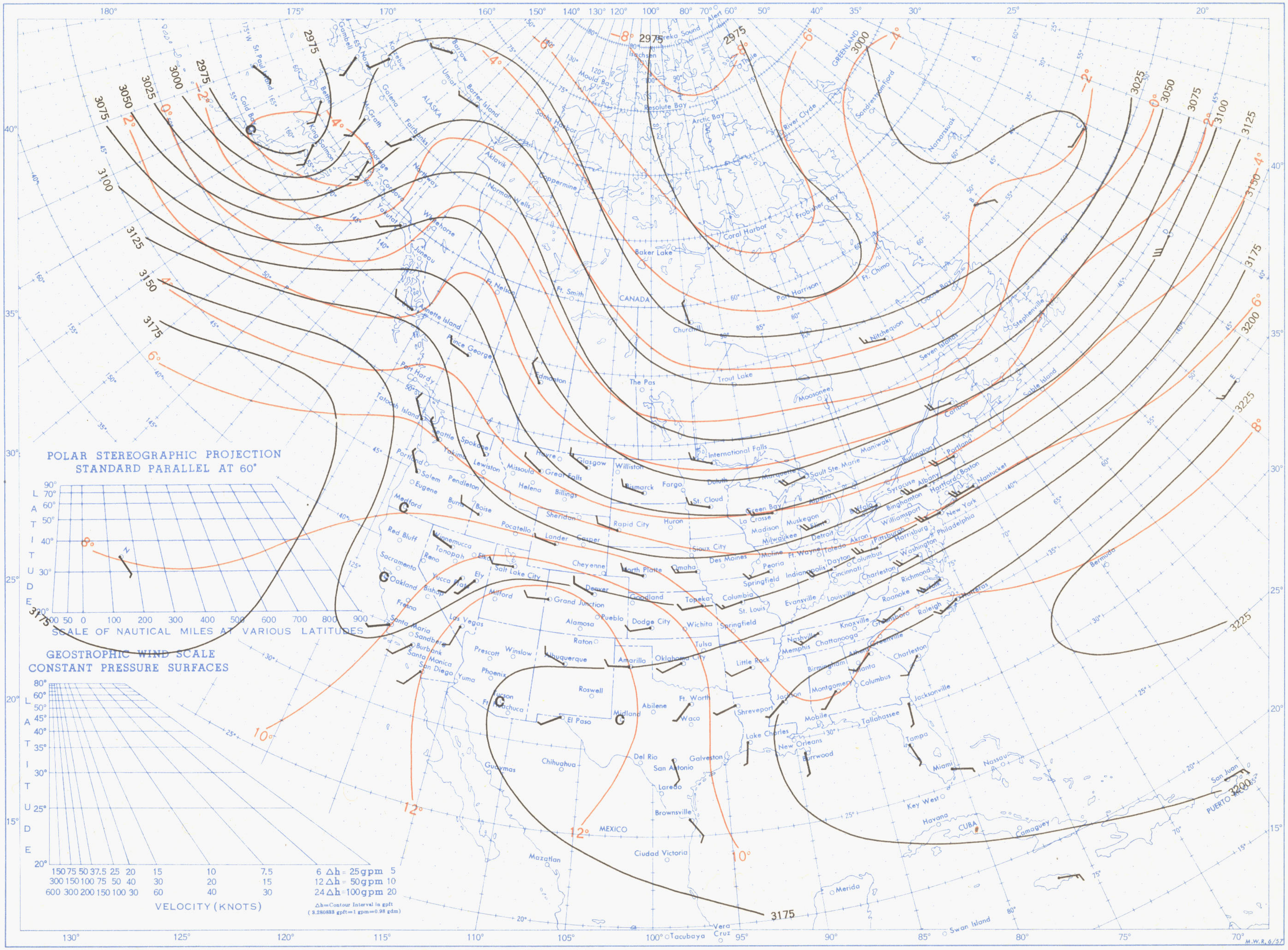
Average sea level pressures are obtained from the averages of the 7:00 a. m. and 7:00 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. 850-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



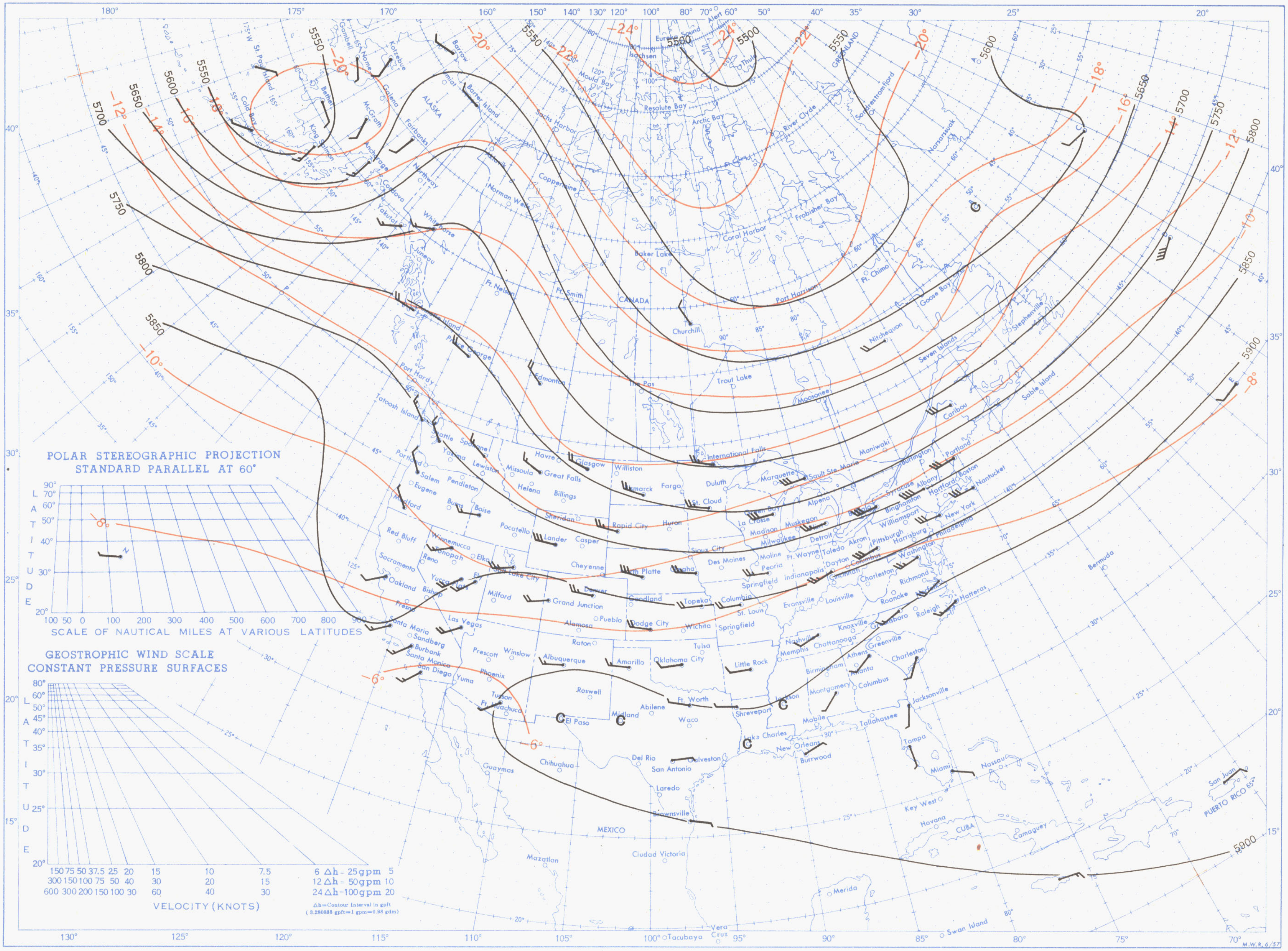
Height in geopotential meters (1 g.p.m. = 0.98 dynamic meters). Temperature in °C. Wind speed in knots; flag represents 50 knots, full feather 10 knots, and half feather 5 knots. All wind data are based on rawin observations.

Chart XIII. 700-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



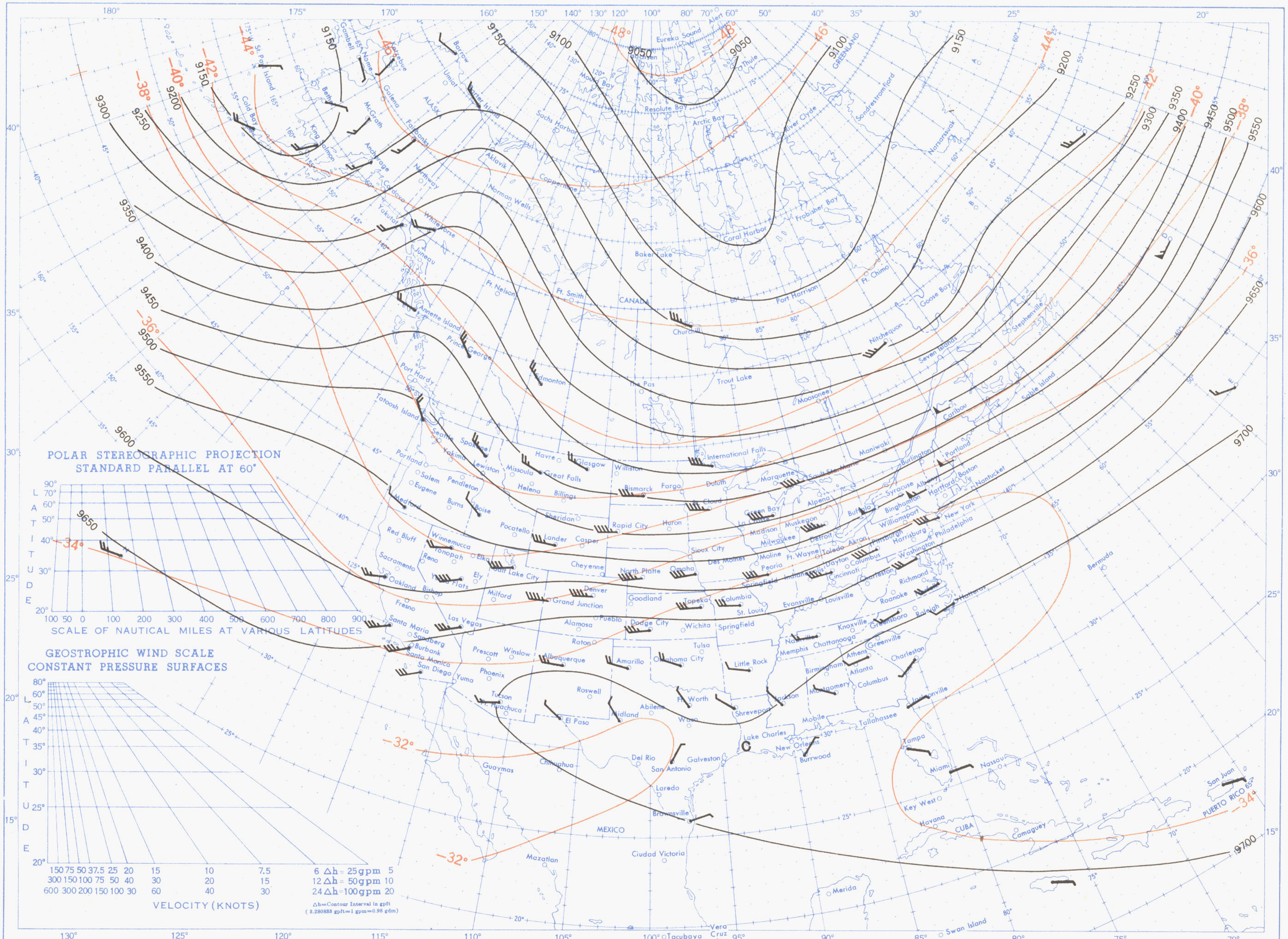
See Chart XII for explanation of map.

Chart XIV. 500-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



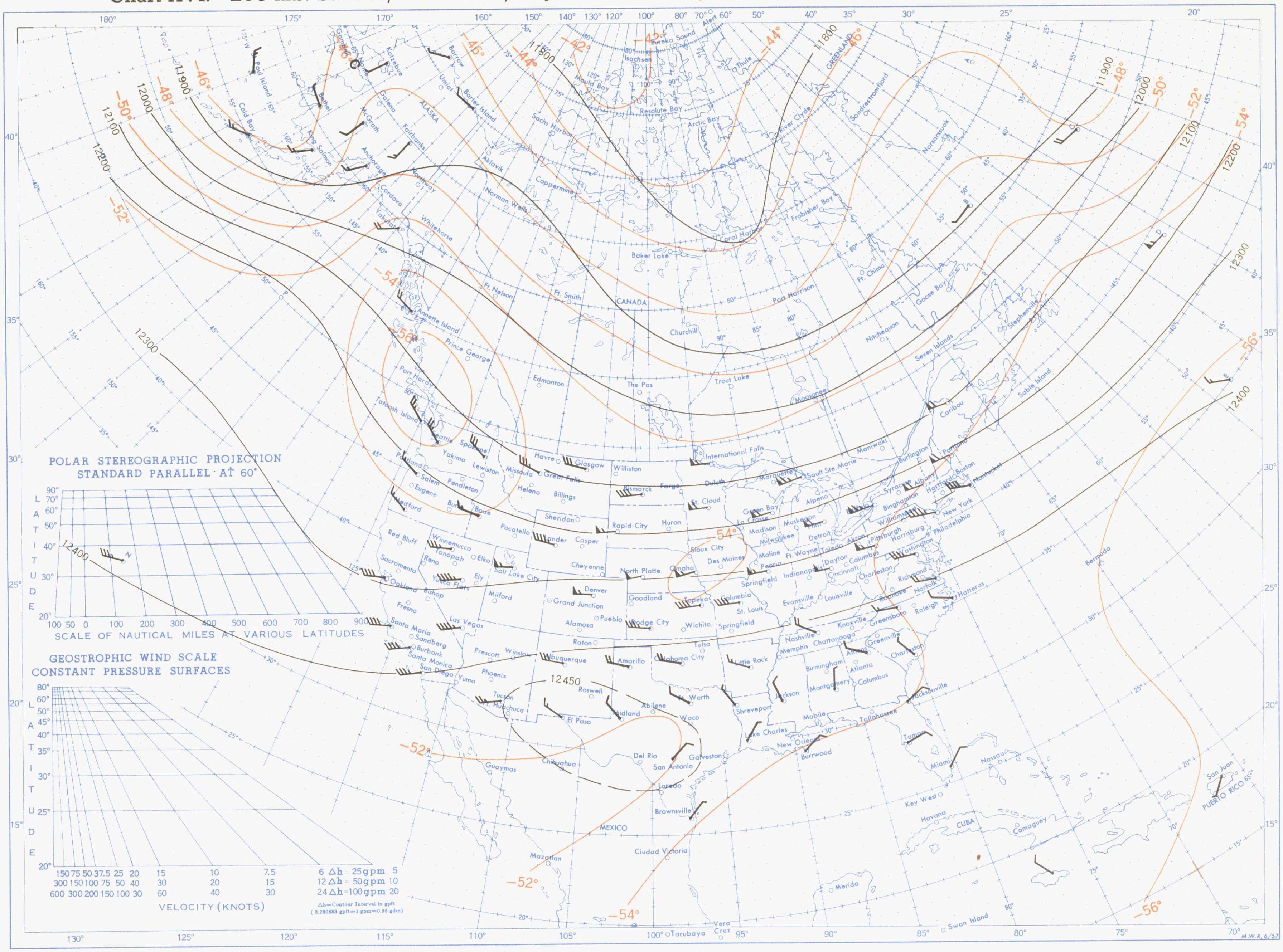
See Chart XII for explanation of map.

Chart XV. 300-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



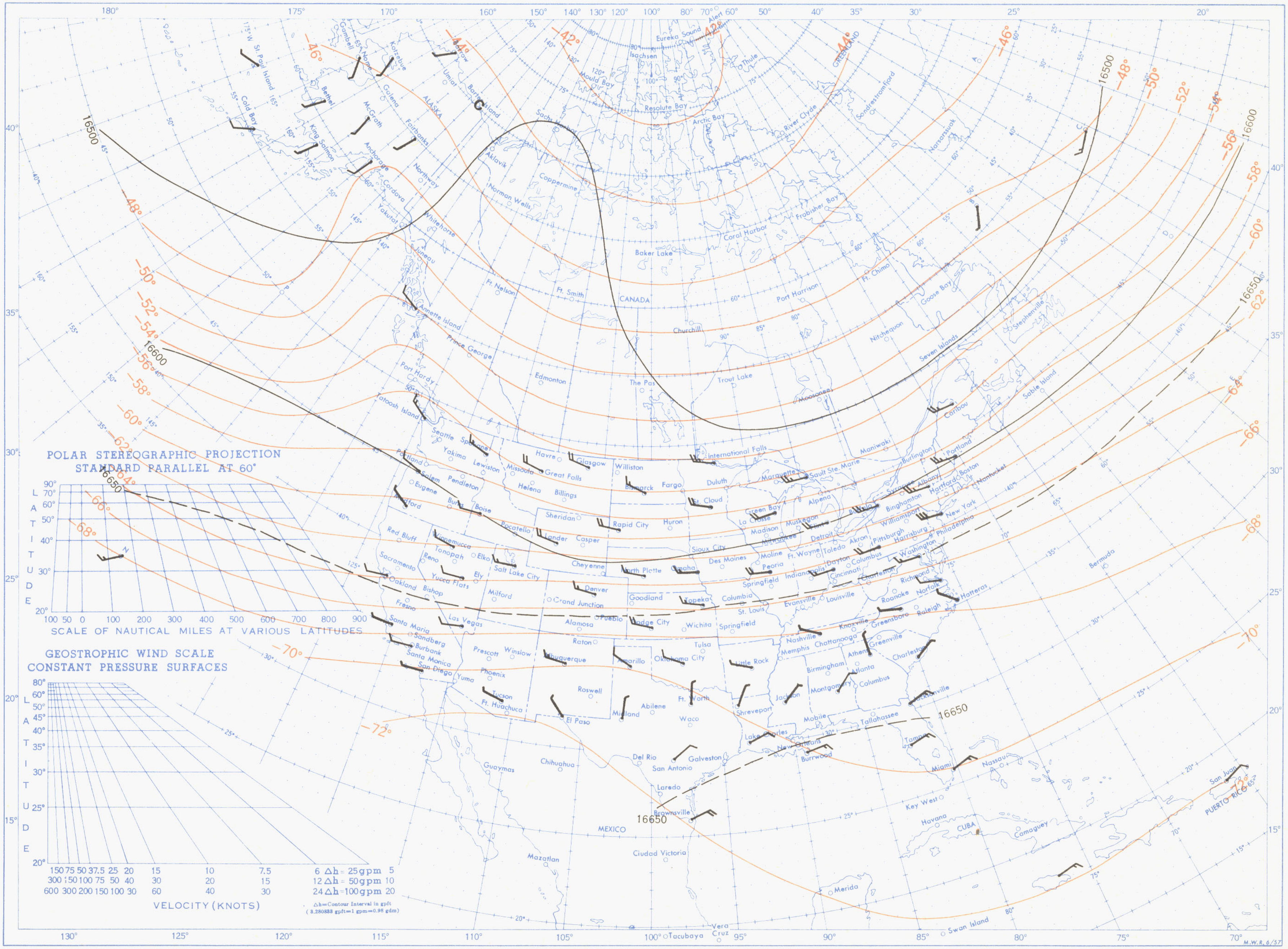
See Chart XII for explanation of map.

Chart XVI. 200-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.

Chart XVII. 100-mb. Surface, 1200 GMT, July 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.